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Combination Steam and Water Plant

INSTALLATION OF SMALL HYDRO-ELECTRIC PLANT OPERATING IN CONJUNCTION WITH STEAM PLANT AT TERRYVILLE, CONN.; WATER POWER END REQUIRES MINIMUM AMOUNT OF ATTENTION

WHILE CONSIDERABLE ATTENTION has of recent years been paid to this country's large hydro-electric developments, we find comparatively little mention in our technical papers of the utilization of the smaller water powers by the isolated plant owners. More of these installations than commonly realized exist, and while some are of an obsolete type, employing old overshot wheels driving, through the medium of gears and belts and long lines of shafting, remotely located machinery, with the accompanying great loss of energy, others possess many of the refinements found in the largest stations operated by water turbines.

In spite of the fact that many of these small streams are not able to supply a sufficient amount of water for continuous operation throughout the 12 months of the year, so that the installation of an auxiliary steam-driven station becomes a necessity, it has been found extremely profitable to take advantage of the available power of these water falls. It must, however, be admitted that in many instances the installation of such a plant, either

FIG. 1. TURBO-GENERATOR SET AND MAIN SWITCHBOARD

as an auxiliary or otherwise, depends to a great extent upon local conditions, and the requirements of the industry in question.

Some of these call for energy for light and power only, while others utilize more or less low pressure steam for manufacturing and heating purposes. Under the former conditions, if sufficient water is available, the entire power may be had from the hydro-electric plant, steam being used only during periods of low water or extreme winter weather. When, however, steam is required at all times, it is advisable to install noncondensing steam-driven prime movers of such size that their exhaust will be just sufficient to furnish the required steam, the hydro-electric plant carrying all of that load in excess of that generated by the steam turbines or engines. Then during those months when the water power is not available, the steam-driven units may carry the entire load, that part of their exhaust not used being allowed to pass out to the atmosphere. Or a condenser may be installed and used only during the

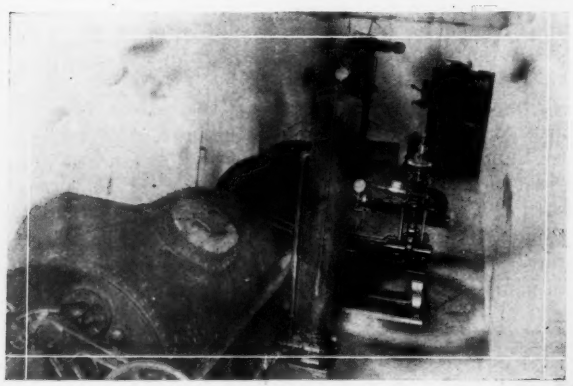


FIG. 2. INTERIOR OF HYDRO-ELECTRIC PLANT

time the steam station is carrying full load, the steam for heating and industrial purposes being obtained from the high-pressure header through the medium of a proper reducing valve, supplemented by that part of the exhaust of the auxiliaries not required for boiler feed heating.

A Typical Installation

Located between the public highway running from Bristol to Terryville, Conn., and the Pequabuck river, are the works of the Andrew Terry Co., founders of malleable iron castings. After an exhaustive study of existing conditions, the engineers employed by this company found that it would be more profitable to install a combined steam and hydro-electric isolated plant to furnish the electrical energy for the driving of the electrical equipment of the foundry than to purchase this energy from hydroelectric companies, whose high-tension transmission lines are nearby.

Integral with the foundry buildings is a small steam generating station, consisting of one 100-hp. Bigelow boiler working under a normal pressure of 125 lb. gage, and equipped with hand fired furnaces, and a vertical auxiliary boiler used at such times as the 100-hp. unit is unable to carry the entire load, or when this boiler may be cut out for cleaning and repairs.

Ordinarily these boilers are fed by injectors, although a power boiler-feed pump is installed and frequently used. When using this pump, a unique method of heating the feed water is employed. The water as it passes from the pump to the boiler, is caused to circulate through a drum placed on the exhaust line of the main steam turbine and having the general appearance of a large steam separator, such as found on high-pressure steam lines, so that a considerable portion of the heat contained in this exhaust is utilized in heating the feed water.

The main steam-driven generating unit is a 156-kv.a., 240-v., 3-phase Westinghouse turbo-alternator receiving its excitation from either a 7-kw. motor-generator set or

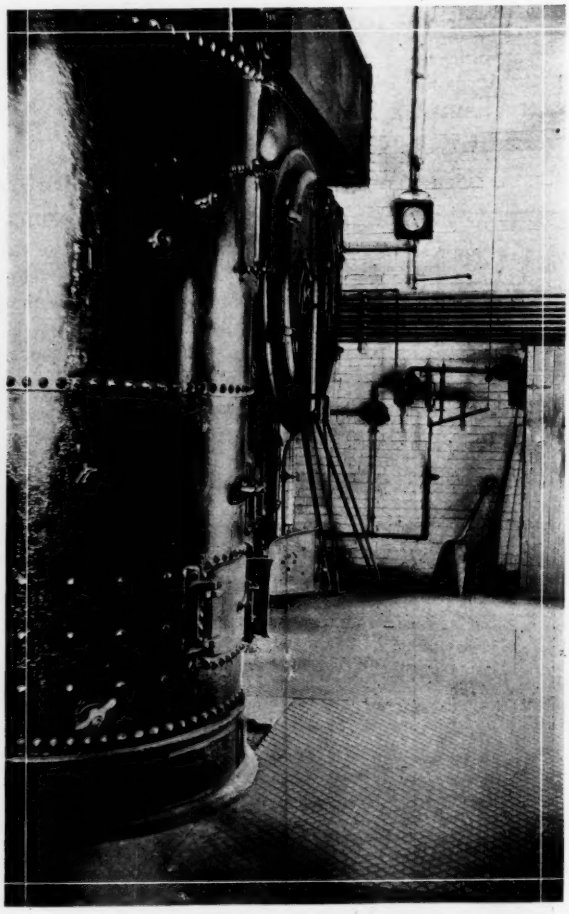


FIG. 3. GENERAL VIEW OF STEAM GENERATORS

an auxiliary lighting unit consisting of a 52-amp., 125-v., General Electric direct-current generator belted to an Erie City Iron Works engine. In Fig. 1 are shown the main generating set, switchboard and part of auxiliary lighting and exciter set in rear.

Hydro-Electric Equipment

This part of the installation is at all times required to work at full water capacity, all overloads being carried by the steam station, so that many times when the load is not excessive and a large supply of water is available, the steam plant is shut down.

Water for operating the turbine is obtained from connecting 3 ponds, and carried therefrom by a 42-in. pen-

stock, the length of which on a 6.35 per cent grade is 325 ft. These ponds have a storage capacity sufficient to run the wheel continuously for 10 hr. while delivering 100 hp., so that even though they become well exhausted during the day, they are readily refilled during the night. During extremely dry periods, when these ponds are unable to supply the demand placed upon them, a reservoir, the Old Marsh, located about 2 mi. above the plant and having a storage capacity of 24,000,000 cu. ft. of water is drawn upon. When, however, recourse to this reservoir is necessary, a considerable part of the load is carried by the steam plant, as it is the object to keep some water in this reserve storage space until the fall rains can replenish that taken out.

The hydro-electric station which is located about ½ mi. from the steam plant, is a low stone, brick and concrete structure, whose highest roof point extends but

Distribution of Energy

As stated above, the hydro-electric equipment is allowed to carry all the load it can, so that it is continually floating on the system, the energy delivered by this set being controlled by a single panel switchboard shown in Fig. 2, which in addition to the regulation generator and exciter switches, voltmeters and ammeters, has mounted upon it a Tirrill voltage regulator, thus reducing the amount of attention required to a minimum. In fact, the writer has been informed by the operators of this plant that for periods as long as 7 days no one enters the building.

Current from the switchboard is carried at 2400 v. over a wooden pole line to the steam plant, where directly outside of the building are located 3 delta connected transformers stepping the voltage down to 240.

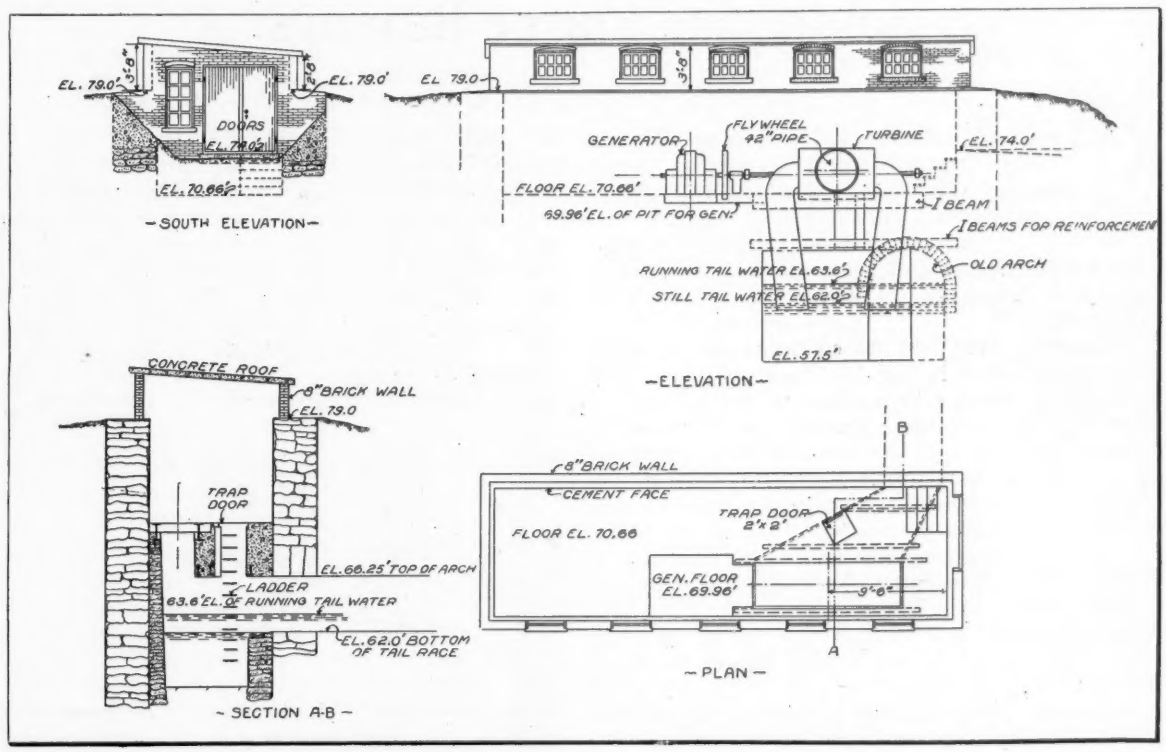


FIG. 4. PLAN AND SECTIONAL VIEW OF HYDRO-ELECTRIC PLANT

3 ft. 8 in. above the surface of the ground. The rest of the building, the main portion of which was formerly used as the pit of a 30-ft. overshot wheel, said to be about 100 yr. old, extends to a depth of over 20 ft. below the ground level. At an elevation of a little less than 8½ ft. below the ground level, and resting upon 15-in. I beams, is a double-runner S. Morgan Smith horizontal waterwheel governed by a Lombard type F governor with a heavy flywheel mounted on the shaft connecting the turbine and alternator to care for any variations of speed. This directly connected alternator is a 135-kv.a., 2400-v.,3-phase Westinghouse machine, served by a 3-kw. belted exciter. The wheel, which under normal conditions operates under a head of approximately 25 ft., is equipped with 2 10-ft. draft tubes.

The secondaries of these transformers are connected to a set of bus bars on the rear of the distribution panel of the main switchboard in the engine room, and run parallel to a second set of bus bars supplied with energy from the steam driven set. The individual feeder circuits, as shown in Fig. 1, are connected to 3-pole double-throw knife switches on the feeder panel, so that any part of the load may be thrown onto either source of power and the load thereby distributed according to the amount of load the waterwheel is capable of delivering at any particular time. Service for lighting is obtained from a bank of 3 transformers stepping the voltage down from 240 to 120.

In addition to the distribution panel, the main switchboard has 3 others, one for the control of the

main generator, another an exciter panel, while the one at the extreme left in Fig. 1 is for the control of the monorail system used throughout the foundry.

Load

The bulk of the load placed upon this generating equipment consists of one 50-hp. induction motor driving an air compressor, 2 20-hp. induction motors running cupola blowers, 3 7.5-hp. motors, 2 of which operate tumbling barrels, while the third is used in connection with a cinder mill, one 15-hp. induction motor directly connected to a Buffalo fan and one 30-hp. motor-generator set. This last mentioned piece of apparatus is used in connection with the monorail system employed throughout the foundry for the purpose of carrying heavy material, and consists in the main of a 30-hp., 3-phase induction motor driving an 18-kw. low-voltage generator.

Final plans for this equipment, according to the information given out by the engineers, Sperry & Buell, of Bristol, Conn., call for 2 additional installations, one of 80 hp. at the old Marsh where a 56-ft. head is available, and the other a 30-hp. unit at a point having a 16-ft. head, so that during low-water periods it will be possible to conserve the water supply to a great extent by using the 2 upper plants one day and the lower plant the next.

A. C. Stieler, chief engineer of the Andrew Terry Co., is in charge of this equipment and it is due to the courtesies extended by him and the designers, Sperry & Buell, that the preparation of this description has been possible.

Adjusting Engine Bearings

Types of Bearings; Their Construction; Proper Adjustments. By C. E. Anderson

Keying up and adjusting the bearings on engines is a "trick of the trade" that can only be learned by practical experience, and no set rule can be given for keying up that will apply to all engines.

We will first consider the main bearings of a high-speed horizontal engine of about 150 hp., which, as a rule, are of the single-wedge draw or pull type with top adjustment.

To tighten these draw up on the wedge by means of the wedge bolt as in Fig. 1. This can be done while the engine is running by slacking off the lock nut on the wedge bolt and slowly drawing up the wedge by means of the other nut to where you think the proper place; then tighten up the lock nut. In adjusting this bearing while the engine is running, it is good policy to take up a little at a time, say 1 flat on the nut or 1/6 of a turn, and watch the bearing for any signs of heating. If the bearing commences to heat, slack back a notch or 2.

When the engine is not running, draw up the wedge so far that the quarter box is tight against the shaft; then slacken back 3 flats on the nut; tap the wedge bolt down slightly with a hammer and set up the lock nut. In ordinary size bearings, this will give a clearance between the shaft and quarter box of about 0.005 to 0.007 in. which is a good running fit.

On larger engines, the main bearings generally have 2 wedges, one on either side of the shaft with 1 or 2 wedge bolts to each wedge, depending on the size of engine or bearing.

The top or cap on this design carries a part of the bearing and should be adjusted carefully. It is not uncommon to find liners between this cap and the engine frame, but this is not in accordance with the engine builder's design or intention. This cap is babbited and should have a running clearance between it and the shaft and should bear on the quarter boxes when it is tightened down by means of the frame or cap bolts.

If the liners are placed between the cap and the engine frame and the cap is not resting on the quarter boxes, the shaft will have a tendency to lift itself and the quarter boxes every time the crankpin passes the top and bottom quarters. If liners are used or needed, always have them between the cap and the quarter boxes.

In adjusting the quarter boxes on 2 or more bearings on an engine having this type or any other type of bearing having 2 quarter boxes, care must be used in taking up the wear to take up a like amount on all the wedges on one side of the shaft; otherwise, the engine will be thrown out of line, which will cause heating or pounding in the engine. The sketch showing an exaggerated case will illustrate my meaning more clearly.

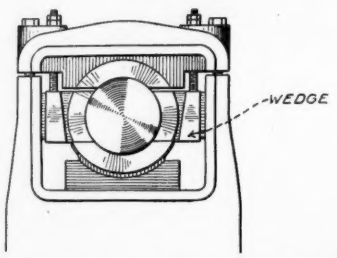


FIG. 1. SECTIONAL VIEW OF HIGH SPEED TYPE OF BEARING

To adjust the top cap in this type of bearing place the cap down firmly on the quarter boxes and tighten down by means of the cap or frame bolts. Test for clearance between the shaft and the cap by means of a strip of paper brass 0.005 in. thick, or a sheet of writing paper; if the paper or brass strip can be inserted and passed through and over the entire surface of the shaft under the bearing part of the cap, you will have enough clearance for ordinary running conditions.

If the clearance between the shaft and cap is less than a paper thickness you should raise the cap to increase the clearance by means of liners between the cap and the quarter boxes until you have the proper clearance. This top cap or bearing seldom wears to any extent as the quarter boxes and bottom bearing receive nearly all of the wear.

On still larger engines, both high and low speed, the so-called 4-piece (it ought to be 5-piece), bearing

is generally used with either top or side adjustment. The top adjustment is by means of wedges as in the bearings we have just considered. The side adjustment type of this bearing has no wedges, but the quarter boxes are adjusted to the shaft by means of bolts in the sides of the bearing or engine frame, some bearings having 1 bolt on either side, that is one bolt for each quarter box, while larger bearings will have 2 adjusting bolts for each quarter box.

In this type of bearing, instead of the cap being a bearing or having a wearing surface we have what is called a saddle, which is a babbited piece something similar to the bottom bearing of the other types of bearings, which fits over the top of the shaft under the cap. This saddle rests on the quarter boxes and the cap in turn rests solid on the saddle.

In adjusting this saddle for proper clearance between it and the shaft, tighten down the cap on the saddle and try the clearance with paper or a strip of thin brass as in the other types of bearings. If the saddle is too close or rests on the shaft, raise it by means of liners between the tops of quarter boxes and the saddle until you have the proper clearance. Never place lines between cap and frame to give clearance for the saddle. The cap should always rest solid on the

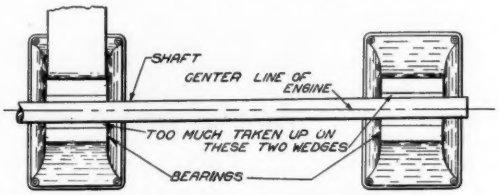


FIG. 2. TAKING UP UNEQUAL AMOUNTS ON WEDGES WILL THROW SHAFT OUT OF LINE

saddle which rests on the quarter boxes and they rest on the bottom bearing or box which rests solid on the recess in the engine frame.

When the bottom bearings of an engine have worn down so that the center of the shaft has dropped below the center line of the cylinder and guides, the shaft can be raised to its proper place by "shimming" up or placing liners under the bottom bearing of sufficient thickness to raise the shaft to its proper place and alinement. In shimming up under the bearings, care must be taken not to shim up more under one bearing than another so that the shaft will be higher at one end than the other; the shaft must be level after the job is done.

Liners for shimming up should be the full size of the bottom of the bearing under which they are to be placed so that the bearing will rest level and solid in the frame and not be liable to a rocking motion when engine is running. Sheet steel is the best material for liners, as it will not squeeze out or wear down quickly as will brass or tin.

In raising a shaft to its proper level, first determine how thick a liner you will need under the bearing to bring the shaft up in place. Then make a single steel liner of the proper size and thickness. Some engineers will use a half dozen thin liners instead of one of proper thickness; these soon wear on themselves.

Main bearings of vertical or upright engines are nearly all alike in construction, of 2 pieces, some being of brass while others are babbited. There is only top and bottom adjustment; that is, you can tighten down the cap by means of bolts or raise the bottom half of the bearing by means of liners. The sketch illustrates the 3 most common types of these bearings.

The bearing designated as A we generally find on small engines and the bearing is adjusted by means of liners between the bottom bearing and the cap. This bearing is really nothing more than a brass shoe cut in 2 lengthwise, one half lying in a recess of the bearing in the engine frame with the shaft resting in it and the other half fastened in the cap on top of the shaft.

The bearing designated as B is a babbited bearing; the bottom half is made of cast iron and babbited for the shaft. This bottom bearing is removable and is held in place in the engine frame by means of dowel pins, either in the bottom of the bearing or on the side of the bearing between it and the frame of the engine.

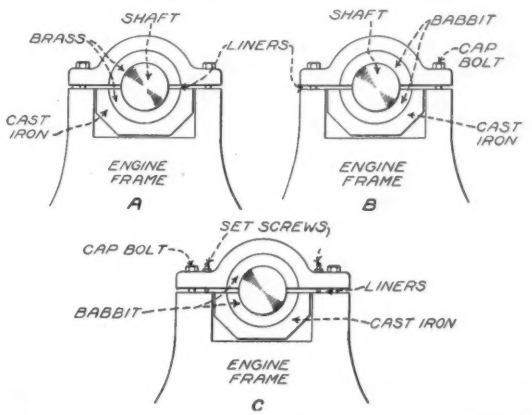


FIG. 3. TYPES OF MAIN BEARINGS AS USED ON VERTICAL OR UPRIGHT ENGINES

The dowel pins are used to keep the bottom bearing from working endwise out of its place in the frame of the engine and causing damage to the engine. The top or cap in this type of bearing is babbited to fit the shaft and is adjusted to the shaft by means of liners between it and the bottom shell or half of bearing.

The other type of bearing, C, is the same as B, except that it is not adjusted by means of liners, but uses set-screws instead.

To adjust this bearing, the cap is set in place and tightened down solid on the shaft by means of the cap bolts, either 2 or 4 in number, depending upon the size of the bearing. Be sure that the cap is down on the shaft and not resting on the set screws. Set the 4 set screws down hard on the engine frame and then slack off the cap bolts a turn or 2, then set the cap screws down again about ¼ turn, which will generally give sufficient clearance; now set up the lock nuts on the set screws and tighten down the cap bolts again. Try the clearance between the shaft and cap the same as in the horizontal bearings described before.

The vertical engine type of main bearing caps are somewhat heavier than those for horizontal engines, due to these caps having a greater strain put on them than on the other type of bearing cap.

Boiler Feed Water--V

ANALYSES OF FAIR, POOR, BAD AND VERY BAD WATER AND WHAT RESULTS MAY BE EXPECTED FROM EACH. CALCULATING WHEN TO BLOW DOWN. BY F. F. VATER

MY object in writing this series of articles is to help every one of you to a clear understanding of what impurity in water consists of; what its effect is and what the cure is, if it is curable.

I have told you the chemical names and effect in general terms and to make it clearer to you, I will give some analyses of feed waters, tell you what kind of a plant they are used in, and what results followed. I will give analyses of a fair, poor, bad and very bad water.

The following analysis is from the water supply used by a large milling company. It is taken from a creek into a jet condenser, and pumped from the hot well into the boiler supply. The boilers are horizontal, water tube type; are worked under good draft for all the steam they will deliver 24 hr. a day; 7 days in a week for 8 months in the year.

ANALYSIS

Substance	Grains per gallon
Silica	2.39
Iron oxide and alumina	.19
Calcium carbonate	2.91
Magnesium carbonate	.93
Calcium sulphate	2.54
Magnesium sulphate	.48
Suspended matter	2.37
Total incrustants	11.81
Sodium chloride	1.30
Sodium sulphate	.39
Nonincrusting solids	1.69
Total solids	13.50

This is what would be called a fair water and under low pressures and no overload, would not cause serious trouble.

Under the load and pressure conditions at that plant, the tube loss alone was $1000 a year, and as the plant had 2000 b.hp., nominal rating, the tube loss equaled 50¢ per horsepower per year.

By tube loss, we mean only the cost of the tube, the freight on it, and the cost of cutting out the old one and putting in the new.

In examining this analysis closely, we will find first the percentage of sulphate or cement it contains: 2.54 grains of lime plus 0.48 grains magnesium is 3.02 grains, divided by the total incrustants, 11.81, shows that 25 per cent plus of the total incrusting matter was sulphate.

Under actual operating conditions, this scale was hard and the turbining required 2 men, 2½ days per boiler and had to be done every 6 weeks. The labor cost of turbining was $12.50 per time, per boiler, 8 times per year. The cost is $100 per boiler, and as there were 6 boilers in the plant, the labor cost for turbining was $600 a year.

You can't cut out of the line a 300-hp. stoker-fired boiler, cool it down, raise steam again and cut it into the line on less than 2 tons of coal; 2 tons, 1 boiler, 1 cleaning, 8 cleanings a year means 16 tons per boiler. Six boilers makes 96 tons wasted in cleaning and this would approximate in value, $192 per year.

The density of this water with total solids, 13.5 grains per gallon, is low, but let us figure out saturation possibilities.

Filling a boiler with water of this quality, and then evaporating it into steam and keeping the boiler full, would give you one evaporation. You would then have doubled the impurity and the water in the boiler would contain 27 grains per gallon. Evaporate 10 times, and you would have a saturation of 135 grains. Work this boiler 50 per cent above its rating, and you would have a saturation of 202.5 grains per gallon. This equals a density of 1.0034 plus. This is a saturation no water tube boiler can stand. Tube loss followed even though the saturation was reduced by blowing down every 8 hr.

You see on the face of the analysis, and disregarding the effect of density, it was a pretty fair water for boiler use. Figure out what must be the result of its use; it is a poor water.

Overloading these boilers 50 per cent of their rated capacity, made this water equal to 20.25 grains of solids per gallon, as far as scale formation and density is concerned, at nominal rated load. Had the overload been 100 per cent, which is sometimes found, it was a bad water.

Now you have the method of figuring when blowing down is necessary. It is time to blow down, when the density reaches 1.0026, equivalent to 151.66 grains per gallon. Divide the total solids as contained in the water going to your boilers into 151.66 grains per gallon, and the result is the blowing down period in hours.

There are some conditions where boilers will stand higher saturations than that given above, but you can't afford to take a chance. Keeping on the safe side will keep lots of trouble off your shoulders.

If you don't know how much solid matter your water contains, find out. You don't need a chemist to tell you, nor do you need an analysis. Take ½ gal. of water; put it in a clean porcelain-lined pan or dish; place it where it is hot enough to vaporize; cover so that no dirt can get in, and evaporate to dryness. Take the dish to your druggist, have him scrape all of the precipitate off, and weigh it in grains. As you evaporated ½ gal., double the weight he gives you, and you have the total solids in grains per gallon. Don't do this just once, and think you know all about it. No water is of constant quality; rivers vary 50 per cent in 48 hr.; do it every once in a while. Taking for granted or supposing you know, has caused more loss than any other waste about a steam plant.

A POOR FEED WATER

THE NEXT example is of a water used by a central station heating and lighting plant. Vertical water-tube boilers are driven to their limit. I have seen the breeching, a low red in the daytime. The boilers are stoker fired, and the operation is continuous. It is practically

a booster heating station and operates 4 months of the year only. The capacity is 6 250 and 4 400-hp. boilers nominal rating.

ANALYSIS

Substance	Grains per gallon
Silica	.20
Iron oxide and alumina	.17
Calcium sulphate	1.00
Calcium carbonate	9.38
Magnesium sulphate	3.05
Magnesium carbonate	3.00
Incrusting solids	16.80
Sodium chloride	2.0
Sodium sulphate	1.17
Nonincrusting solids	3.17
Total solids	19.97

This would be called a poor water and even under low pressure and no overload will cause trouble. Under the operating conditions named above, the trouble was serious. In 4 months' operation, the tube loss was $2000. As the plant was equipped with 3100 hp. nominal rating, the tube loss is practically equal to 75¢ per hp. for 4 months. Had the plant operated 12 months, the tube loss would have been $3 per hp. per year.

The percentage of sulphate to total solids is 24 plus. Under actual operating conditions, this scale was hard. The accumulation in an 8 weeks' run was so heavy, you could not start a turbine without first chipping out by hand. This condition existed even though soda ash was fed by gravity into the suction of the feed pump.

I am not in possession of the labor cost of cleaning, but it was much higher than in the instance first given. Nor have I the records of how frequently the boilers were blown down.

If the density was kept down to the standard of 1.0026, it would have required blowing down every 7½ hr. The tube loss was due both to scale accumulation and density. This water was practically free from suspended matter and clear. The impurity was all in solution. The nonincrusting solids are not yet high enough to worry about.

EXAMPLE OF BAD WATER

THE NEXT example was taken from a central electric railway, lighting and hot water heating plant. The water is obtained from a stone quarry, the supply being maintained from springs in the crevasses of the rock. The plant contained 4 horizontal return tubular boilers, 72 in. by 18 ft, nominally rated at 150 hp. It was under good draft and they were overloaded at peak loads.

ANALYSIS

Substance	Grains per gallon
Silica	0.696
Iron oxide and alumina	0.464
Lime carbonate	4.176
Lime sulphate	7.946
Magnesium carbonate	12.354
Magnesium sulphate	8.874
Incrusting solids	34.490
Sodium chloride	3.828
Sodium sulphate	13.050
Nonincrusting solids	16.878
Total solids	51.368

This is a bad water. There is nothing good about it. Having horizontal tubular boilers with the water on the outside of the tube, the scale also was outside and no tubes were lost, due to collapse. It was necessary, however, to retube the boilers every 18 months. They burned off at the heads. The coal consumed per kilowatt-hour is 8½ lb.

Examining this analysis, the percentage of sulphate is 48.7, very nearly one-half of the incrustants being sulphate. This, under any condition but one, would make a hard scale. That one condition will be illustrated in the next example.

To keep the density down to 1.0026, the boilers would have to be blown down every 3 hr. The nonincrusting solids are high enough to have become troublesome even in a horizontal tubular boiler. In a water tube type, this water could not be used without scientific treatment, and even then, blowing down would have to be frequent. Foaming in this plant was frequent and severe.

A great deal was being done in this plant to get rid of trouble. A live steam purifier was installed, which succeeded in removing the carbonates pretty thoroughly, but left the sulphate in the water. The scale was dense and hard. The boilers were cleaned every 3 weeks and the scale on the plates was chipped off.

In addition to the live steam purifier, the engineer was trying to better himself by feeding lime and soda ash, but the method he employed was inaccurate naturally, and he only obtained some benefit. Money enough had been spent in this plant to have equipped it with a first-class softener.

As stated above, the nonincrusting solids in this water are high enough to cause serious trouble. Figure the density to nonincrustants alone, and it is 1.003. Just figure for yourself what the concentration due to evaporation would mean.

WATER UNFIT FOR MODERN BOILER

THE FOURTH and last example. Plant, central station lighting and heating; 1 vertical water-tube boiler and 2 horizontal water-tube boilers; pressure 150 lb.; no overload because it could not be obtained; loss of tubes constant and heavy; foaming serious and almost continuous. The water was taken from a well 916 ft. deep into St. Peter sand stone.

ANALYSIS

Substance	Grains per gallon
Silica	0.10
Iron oxide and alumina	0.20
Calcium carbonate	15.18
Magnesium carbonate	1.20
Calcium sulphate	8.49
Magnesium sulphate	15.56
Incrusting solids	40.73
Sodium chloride	15.50
Sodium sulphate	58.98
Nonincrusting solids	74.48
Total solids	115.21

This water is not usable in anything but an old-style fire-flue boiler, under about 80 lb. pressure and no overload.

Percentage of sulphate to incrustants, 59. This large quantity of sulphate in the water does not form scale. The noninerusting solids were so high as to prevent incrustation. The trouble was due to density and density alone. To hold the density to a standard of 1.0026 required blowing down every 1.3 hr., which practically means blowing all the time.

I have no record of coal consumption at this plant, but it must have been heart-breaking.

We cannot but draw the conclusion from the foregoing data that fair water needs treatment, and that there are impossible waters.

The last example given is not the worst. I have met cases where the total solids reached 284 grains per gallon. This last-named water is being evaporated in fire-tube boilers working not to exceed 75 per cent of their rated capacity with steel drums over every engine throttle 5 ft. diameter, 15 ft. long.

Boilers are washed out every 3 days and are retubed every 8 months. It seems hardly necessary to say that in this instance absolutely no other supply is available without investing $60,000 in the plant and carrying a pumping cost exclusive of interest and depreciation of 6¢ per 1000 gal.

(To be continued.)

Efficient Operation of Boiler Rooms

TWO POWER PLANTS REQUIRED BY DIRECT DRIVEN KNITTING MILLS. MORE INSTRUMENTS REQUIRED TO GIVE SUFFICIENT RECORDS AND ALLOW FOR ANALYSES OF PLANT OPERATION

THE character of the work done in knitting mills requires an abundance of sunlight and this need calls for more or less spreading of the buildings. Fire hazard is also great in works of this kind so crowding buildings together is avoided as much as possible; also because of this danger the progress of electric drive has been slow. The plant to which your attention is called in this article is a typical New England knitting mill of large proportions having its machinery driven by ropes, line shafting and belting, just such a plant as would delight the heart of a millwright. Power with them is a necessity, not a specialty, and while it is one of the big expenses, its production is not given the consideration other departments of the mill receive; yet the power plant equipment has been selected with great care, but lacks instruments for making records and investigations which are necessary for best operation.

Owing to the ground covered by this industrial plant it is served by 2 power houses; these are detached buildings entirely separate from each other and drive the mills through rope transmissions. Electric generators furnish current for lighting purposes only. In No. 1 power plant are 8 Bigelow Manning boilers, each of which has a shell 20 ft. 10 in. long, containing 284 2½-in. tubes 15 ft. long. The joint efficiency of the boiler is 93.07 per cent, the longitudinal seam being of the quadruple riveted butt and double strap type. The thickness of the plate is 9/16 in. and the tensile strength is 55,000 lb. per sq. in. The boilers are operated at a pressure of 165 lb. gage but the allowable pressure is 171 lb.

This type of boiler being internally fired, requires no brick setting. The grate which is of the stationary type is 7 ft. in diameter. The load placed upon the plant is quite uniform throughout the day and the boilers are normally operated at about 25 per cent above their rating. The height of the tube sheet above the grate is 4 ft. 5½ in., which has been found satisfactory for the kind of coal used and the load carried.

Water columns of the high and low alarm type are located about ⅓ way down on the tubes. This gives considerable superheating space to the boiler, but the exact amount developed is not known. A fusible plug is located on one of the back tubes 2 ft. below the first gage cock on the water column; the tube in which this plug is placed is made extra heavy in order to allow for the connection.

The feed water discharge pipe enters the shell of the boiler about ⅓ the way up from the lower to upper tube sheet and a perforated pipe extends clear across the boiler, ending with a plug on the outside of the shell at the opposite side through a reinforcing ring in the shell; there is but one feed line to the boiler, but this is used by the discharge from the pump or an injector. Water level is maintained by means of hand regulation.

The blowoff connection is from the bottom of the water leg at the back and consists of a 2½-in. pipe in which is placed a globe valve. The surface blowoff is even with the second gage cock and consists of a 1½-in. pipe in which is placed an angle and a globe valve made by the Star Brass Co.

Two 3-in. pop safety valves are placed on each boiler by means of a special pipe with Y connection and set to blow at 170 lb., a difference, however, of 1 lb. is allowed between the blowing pressure of the valves. These valves blow back 3 to 4 lb. and are tested every day.

There are no manholes on the shell of these boilers but 28 hand-holes 2½ by 3½ in. are located around the edge of the water leg, 5 around the bottom, 3½ by 5 in., also 1 opposite fusible plug, 3½ by 5 in.

There are no steam baffles, dry pipes or domes, but the steam is superheated somewhat before passing to the header, as the upper ends of the tubes are not covered with water.

These boilers are, as stated above, provided with stationary grates and one firing door. The ordinary coking method of firing is employed and the ash door kept open continuously. New River coal which has an average heat value of 14,000 B.t.u. per pound is used, this is of the run-of-mine grade, lumps being broken up by the firemen. The thickness of the fuel bed carried is about 14 in., but the exact rate of combustion is not known, as no means have been provided for keeping an

accurate record. Neither is a record kept of the draft over the fire during operation of the boiler, owing to the lack of a draft gage. An automatic damper regulator controls a damper in the main flue, but the dampers for the different boilers are hand operated.

As coal is delivered to the boiler room floor direct from the coal yard, a definite record is kept of the amount of coal burned each day. There is storage space in the yard where coal is kept to be used as required in case delivery cannot be made promptly from the coal yards. There is no provision made in the plant for measuring feed water to the boiler nor the steam delivered from it.

For measuring the temperature of the feed water, a recording thermometer is employed, giving the average temperature reading as about 208 deg. The exhaust from the main engine passes through a heater on its way to the condenser, and this raises the temperature of the feed water 70 or 80 deg. From this primary heater the feed water passes to the secondary heater, which uses the exhaust from auxiliaries and heats the water to about 208 deg., when it passes to the boilers. Both of these heaters are of the closed type.

The temperature of the flue gases is read every hour and averages about 450 deg. There is, however, no means for analyzing the gas in this plant so that the furnace conditions are largely results of guess work.

Feed water is treated with a sal soda solution and graphite is also being tried out to eliminate scale troubles. There is not a great deal of scale-forming material in the water, but what there is is very hard and by means of the treatment given there has been no difficulty with scale in boilers. Each boiler is washed out every 4 weeks. After being shut down, it is allowed to stand ½ day before being opened, and is idle about 3 days before it is put back upon the line. There is no means provided for removing scale from the water side of the tubes but the insides are scraped clean of soot every third week; no means, however, of blowing out the soot during the operation of the boilers have been provided.

Ashes are removed every 24 hr. and the fires are cleaned at night, this work all being done by the night firemen. When the fires are being cleaned, one side of the fire is built up while the other is allowed to burn down. When but a few live coals remain on this side, these are winged over and the clinkers and ashes pulled out of the furnace. The live coals from the other side are then winged back to the clean side of the furnace, more coal is thrown on and the process of cleaning the other side of the furnace is carried out in the same way as with the first.

To scrape the ashes through the grate, a T bar is used and the slice bar is used only to break up clinkers such as are apt to form when the boilers are banked at noon or during the night. The T bar is used every 3 hr. and the fire is replenished every 10 to 15 min.

After the ashes have been removed from the ashpit, a small amount of water is placed there to decrease the formation of clinkers and this together with the slight use of the slice bar has proved efficient for this purpose.

Boilers are blown down one gage every morning from the bottom blowoff and the surface blowoff is also used once a day.

These boilers furnish steam for a 1050-hp. C. & G. Cooper compound condensing engine driving the factory with a rope drive, an engine of the same rating direct connected to a 750-kw., 3-phase generator, and for the hot water heating system, the circulating water being passed through a live steam closed heater. The water columns are blown down every morning, and the gage cocks are opened up at the same time to insure that the connections are free of obstructions.

The boilers are all insulated with 85 per cent magnesia covering 2½ to 3 in. thick.

In plant No. 2 are 10 Dillon Manning boilers, each rated at 200 hp. and carrying 185 lb. pressure with safety valves set to blow at 192 lb.

In this plant the boilers are arranged in 2 batteries of 5 each and the boilers are cleaned every other week, one battery being sufficient to carry the load. Economizers are employed here, but it is reported that these are of no value in the operation of the plant.

The boilers are fired in rotation not more than 2 having the fire doors open at one time. The alternate wing system of firing is employed and the fuel bed is kept as near 10 in. thick as possible. The fires are cleaned every night and the ashes are removed at the same time. A draft of 0.6 in. over the fire is that ordinarily obtained when the fire doors are closed. In the stack a recording draft gage indicates an average of 1.2 in. The feed water averages about 232 deg.

During our visit to these plants, we noted evidence on all sides that those responsible for the operation were doing their best to keep the machinery in tip-top condition and with proper encouragement from those in authority, we have no doubt, would show gains in economy which would surprise the bookkeeping department. Means for weighing coal as fired, making flue gas analyses, determining output of boiler and engine rooms systematically are among the most important equipment needed in these plants.

IT HAS long been conceded that graphite paint is probably the most satisfactory protective coating to use on severely exposed metal and wood surfaces owing to its ability to resist corrosive influences of the most malignant character, its great covering power and its remarkable durability.

There is a pure graphite paint and a graphite paint the pigment of which contains some silica. The efficiency of graphite paint, however, is due to the purity of the graphite used in its composition, so it is then logical to regard purity as the correct measure by which to determine the comparative values of different graphite paints—that is to say, one may consistently assume that the graphite paint sustaining in the greatest degree all of the advantages claimed for graphite coatings must, in the nature of things, be that which is made from the purest graphite. Otherwise why use graphite paint at all?

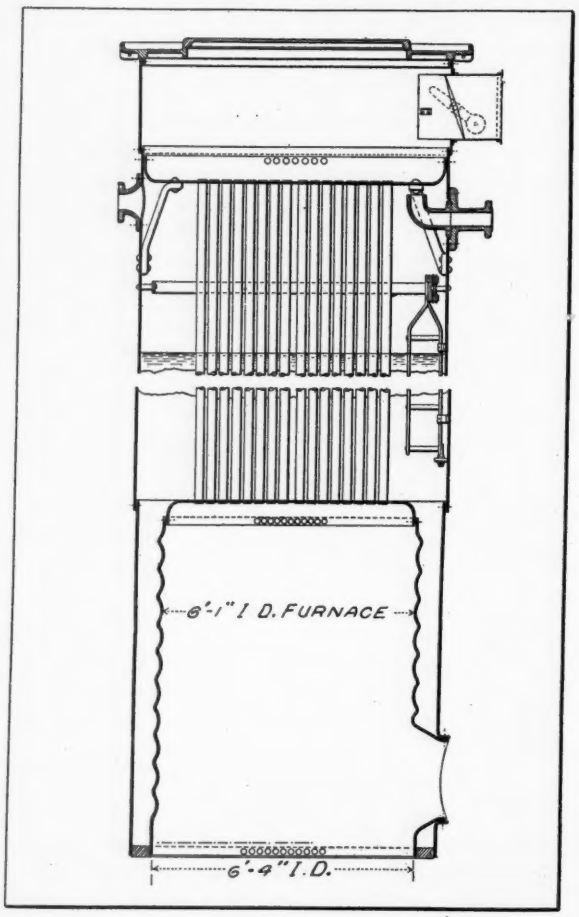
Pure graphite will stand rather severe acid exposures and there are other exposures and corrosive influences brought to bear on paint that fail to affect graphite, yet may have a bad effect on silica, hence the statement that pure graphite paint is superior to a paint containing silica.

Corrugated Furnaces for Vertical Fire Tube Boilers*

ELIMINATION OF STAYBOLTS AND PROVISION FOR EXPANSION AND CONTRACTION OF TUBES ARE SOME ADVANTAGES OF THIS TYPE FURNACE. BY F. W. DEAN

BY the use of corrugated furnaces for vertical boilers, staybolts are done away with, and as there appear to be no disadvantages in the furnace, this is a most important feature. As many hundreds of staybolts are avoided in each boiler, there are just so many less opportunities for breakage and needed repairs.

This type provides for expansion and contraction of the tubes in a safe manner, but on account of its somewhat flexible character it should be assumed that it is



VERTICAL BOILER WITH CORRUGATED FURNACE

advisable to support the lower tube plate as near the edge as practicable. The ordinary firebox is rigid vertically and supports the edge of the lower tube plate, but as the corrugated firebox has slight elasticity it is best to hold up as much of the tube plate as practicable by the tubes and provide little or no elasticity in the tube plates. The flat and unstayed portions of the upper and lower tube plates should be made equal in diameter in order to balance.

*Abstract of paper read before the A. S. M. E.

The behavior of the firebox end of the boiler when under pressure led to some speculation, for the area of the fire door opening theoretically unbalances it. When under hydrostatic pressure, various gages were used for showing distortion, but none could be discovered.

In regard to sizes of such furnaces the catalog of an American maker gives 60 in. as the maximum inside diameter, but in fact this company can make them up to 72 in., and almost 1 in. thick. They have been made slightly larger in Germany and the furnace of the boiler illustrated was obtained in that country. If the inside diameter is 72 in., the grate will be 3 in. larger or 75 in., and the grate area 30.68 sq. ft. It is easy enough to generate 200 hp. on a grate of this size with considerable capacity for forcing beyond this, and there is no difficulty in providing the heating surface for this horsepower.

In regard to pressure, a furnace 72 in. in diameter and 0.95 in. thick will carry 200 lb. If there were sufficient demand for larger furnaces they would probably be forthcoming. The theory of heat transmission through plates, and experience, show that thick furnaces, especially if without riveted joints, are unobjectionable.

The type possesses the important qualities of giving maximum and permanent economy, superheating the steam from 20 deg. to 40 deg., being free from brickwork and requiring small floor space per horsepower.

Oil Troubles that "Didn't Amount to Anything"

BY N. G. NEAR

I KNOW a small western power station that is run on a fairly efficient basis. It is a municipally owned plant, furnishes light and power and operated noncondensing, the exhaust steam being used for heating business and school buildings in the vicinity. There all exhaust is used during the winter months and the condensate returned to the power plant. This is, however, oily and no oil filter or grease extractor is provided in the feed-water line, as the engineer thinks such a device is unnecessary because he "has to renew the boiler tubes once every year anyway," and they clean the boilers "every so often."

It was found, for instance, that a new boiler leaked after one week of service on account of oil. The engineer admitted that oil caused it. Yet, he figures that an oil-extracting device would be unnecessary and uneconomical.

Where a man like this has formed the habit of renewing tubes regularly, where he thinks this has to be done "anyhow," and where he can prove that he can "get along" without new-fangled devices, he can be convinced only with most remarkable difficulty that he is wrong and that considerable money can be saved with economizing and safety apparatus.

This human failing seems to be more prevalent in the smaller power plants. The smaller the plant, usually, the worse the conditions.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Watthour Meters

THEIR PROPER INSTALLATION, CARE AND ADJUSTMENT DETERMINE THE ACCURACY OF THE OUTPUT AND EFFICIENCY OF THE PLANT. CORRECT METERS MEAN CORRECT REPORTS. BY O. H. HENSCHEL

SWITCHBOARDS were first equipped with ammeters and voltmeters, from the readings of which the plant output could at any given instant be readily calculated. With the introduction of inductive loads on the alternating-current circuits and greater outputs on the direct-current lines, it became necessary to employ some form of indicating wattmeter, so that when taking meter readings, the switchboard attendant could read directly the amount of energy being delivered at the time. These readings were generally recorded, and in many cases plotted, thus giving an approximate load curve. With the more efficient methods of operation, however, came the integrating wattmeter, or watthour meter today universally used as the standard for the measurement of electric energy. The difference between any 2 successive watthour meter readings, whether ½ hr. or one day apart, will give the actual amount of energy flow during the period in question, resulting in the acquisition of definite information regarding the output of the plant. These instruments, like others of like delicate construction, require periodic inspection, cleaning and adjustment, as the apparent output and efficiency calculations of the plant vary directly as their accuracy. A slow meter, one measuring less energy than actually generated, will cause the plant efficiency to appear low; a fast meter will do the opposite.

Watthour meters may be divided into 3 general types: commutator meters, mercury meters and induction meters. Of these we find, due to the more general use of alternating current and greater simplicity, accuracy and lower cost of the instrument, the last type is used in greater numbers than either of the others. The commutator meter, while applicable to alternating-current work, is mostly used on direct-current circuits.

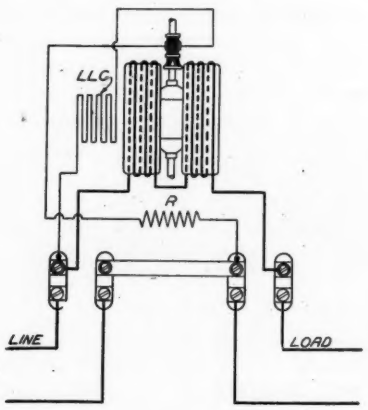


FIG. 1. DIAGRAM OF CONNECTIONS OF COMMUTATOR TYPE WATTHOUR METER

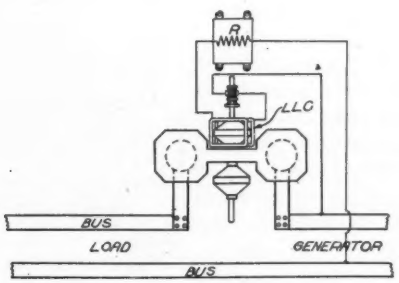


FIG. 2. DIAGRAM OF CONNECTIONS OF ASTATIC WATTHOUR METER

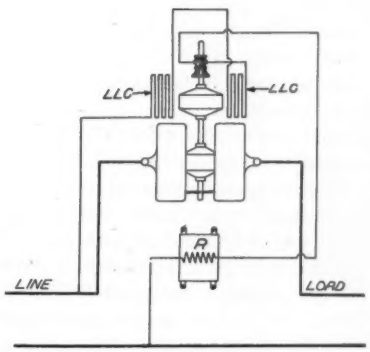


FIG. 3. DIAGRAM OF CONNECTIONS OF SMALL-CAPACITY ASTATIC WATTHOUR METER

COMMUTATOR METERS

THESE CONSIST of a small armature mounted upon a steel shaft, and revolving between 2 field coils, which carry the load current and produce the magnetic field in which the armature rotates. The armature or rotating element is similar to that of a direct-current motor.

In Fig. 1 is shown the diagram of connections of such a meter in which the field coils are connected in series with the load, while the armature circuit consisting of the armature, an adjustable light-load coil, LLC, and a resistance, R, is connected across the circuit. The current through the armature winding, or pressure circuit, varies with the voltage which, on constant-potential circuits, is maintained at practically a fixed value.

The strength of the field varies with the load current, and, as the steady torque due to the potential circuit and that due to the load current are acting at all times the meter is in operation, the torque acting on the armature is proportional to their product, or the power.

In order to make the speed proportional to the power, some form of mechanical load must be provided with a counter torque proportional to the speed. This counter torque is generally obtained by mounting on the armature shaft a disk or cup-shaped piece of copper or aluminum, arranged to revolve between the poles of several permanent magnets. The eddy currents induced in the disk or cup react with the field of these permanent magnets, producing a counter torque proportional to the speed. As the speed increases, the counter torque of the disk or generator element also increases, until a speed is reached where the 2 torques balance each other and the speed remains constant for a given load. Thus, neglecting friction of the moving parts, the speed of the rotating element varies with the power.

In addition to the main field coils, most meters of this type are provided with a smaller coil of fine wire, referred to above as the light-load coil, connected in series with the armature or pressure circuit, and mounted in such a position that its plane is parallel to that of the main or series coils. The direction of current flow around this coil is the same as that in the series coils, so that the effect of these 2 coils is in a like direction. This coil is commonly known as the light-load, friction or compensating coil, its function being to produce the torque required to overcome the friction of the moving parts. The friction existing in modern meters is exceedingly small, yet if some means is not provided for overcoming it, the meter will not register accurately on small loads.

The magnetic effect of this coil on the armature is usually adjustable in one of 2 ways; its position with respect to the armature may be changed, resulting in increased or decreased torque, as the coil is moved to or from the armature; or, the number of active turns in the coil may be changed, resulting in a change of torque without changing the position of the coil.

Speed Adjustments

Light-load speed adjustments are made as above stated. For any other than light load adjustment, the speed of these meters, as in almost all watthour meters, may be varied for a given load by changing the position of the damping magnets. In those instruments employing disks, turning the magnets toward the shaft results in an increase of speed, while turning them in the opposite direction produces a decrease of speed.

In meters with cups, the damping magnets are placed vertically, allowing part of the magnetic flux passing from one pole to the other to be shunted through the air gap. That is, the magnet may be raised or lowered so as to place sufficient of the cup in the direct path of the flux to produce the necessary retardation. The greater the section of this cup acted upon by the magnetic flux, the greater the damping effect and the lower the speed.

Astatic Watthour-Meters

In high-capacity work, where difficulty would be encountered in building series coils to carry the heavy currents, the astatic meter is used. This operates on the same principle as the commutator type, although its construction is somewhat different, the mechanical and electrical design being such as to make it essentially for the switchboard, where it is most generally employed.

The current circuit of the astatic meter consists of a flat copper strip of suitable cross-section placed horizontally in the space between 2 armatures mounted as shown in Fig. 2. The ends of this strip or bar terminate in large copper heads, into which are fixed the studs extending to the rear for connection to the line.

On account of possible errors brought about by strong fields projected by the incoming and outgoing buses, the armature or potential circuit is made astatic, that is, 2 fields of opposite polarity are provided so that any external field projected upon the fields of the potential circuit will produce equal torques in opposite directions, thus counteracting all possible errors from this source. This is accomplished by using 2 closed-coil lap-wound armatures mounted one above the other on the same shaft. Each of these armatures is provided with ½ the number of turns which would be used for one armature, and the 2 are electrically connected in series so that their combined magnetizing effect is equal to that of one armature with twice the turns per coil. As the coils are distributed over 2 armatures instead of one, giving 2 resultant fields in opposite directions, in order to give the required turning effect and at the same time the astatic arrangement for strong field protection, it is only necessary to place these 2 armatures in the influence of the field from the current circuit in such a manner that the torque of both armatures will be in a like direction, as is done in the arrangement shown.

In order to keep the full-load speed of meters of various capacities the same, and in order to employ constant magnet strengths, one of the armatures is adjustable vertically, allowing the torque to be varied at will without necessitating the use of the same number of ampere turns in the current circuits of the various sized meters when operating at full load.

In the smaller capacities of the astatic type of meter, instead of the connecting bar or strip, 2 coils are provided with the lower armature placed within as in the regular type of commutator meter. The second armature, which is adjustable, is placed directly above so as to intersect the current field in the opposite direction.

The damping system consists of a copper or aluminum disk mounted at the lower end of a comparatively long shaft, with the disk and magnets enclosed in a case of magnetic material to eliminate as far as possible any effect the field coils may have on the damping system.

Two light-load coils are generally provided. These are sometimes placed so that both coils act upon one armature and at other times so that one acts on each armature. In either case the 2 coils are connected in series with each other and in series with the armatures, the connection being such that both coils produce torque in the same direction. As in the regular type, these coils are arranged so that the torque at light loads may be increased by moving them toward the armature and decreased by shifting them in the opposite direction.

Electric Locomotives for "Dan Patch" Electric Lines

THE Minneapolis, St. Paul, Rochester & Dubuque Electric Traction Co., operating what is popularly known as the "Dan Patch" Electric Lines, has recently placed in commission 3 60-ton gas-electric locomotives for freight, passenger and terminal service, somewhat similar in design although heavier than the 57-ton gas-electric locomotive which has been in successful operation daily on that company's lines for the past year or more from Minneapolis to Mankato, Minn. The 4 gas-electric locomotives, as well as 13 gas-electric motor cars which the railway company has purchased to date, were designed and built by the General Electric Co.

These new locomotives, double ended and built with the box type of cab extending nearly the entire length of the underframe with all the weight on drivers, are equipped with power plants consisting of 2 generating sets similar to those used in the gas-electric motor cars. Generating sets and the controllers are installed in each end of the cab, while the auxiliary lighting set, air compressor and storage tanks are grouped in the central section.

Each of the 2 generating sets is composed of a 175-hp., 550 r.p.m., 8-cylinder, 4-cycle gasoline engine of the "V" type, direct-connected to a 600-v. commutating pole, compound-wound electric generator with an outboard

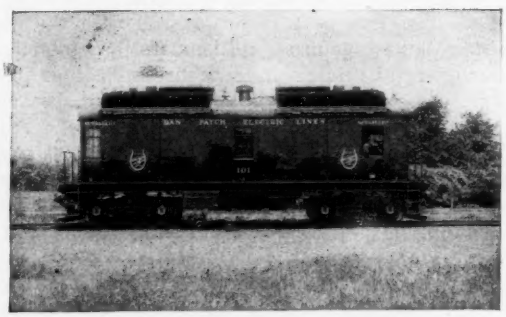


FIG. 1. SIDE VIEW 60-TON ELECTRIC LOCOMOTIVES

bearing supported by brackets bolted to the magnet frame. The cylinders are 8 in. in diameter by 10-in. stroke. Ignition is accomplished with low tension magnetos and the sets are started by air pressure, with the additional feature that after one set is running, the second may be started from the first electrically. The control is so arranged that either one or both generating units may be used to operate the locomotive from either end, in accordance with the requirements of the trailing train load.

Cooling water is circulated by a rotary pump, the water jackets being cast integral with the cylinders and heads. The gasoline pumps are of the plunger type, the main pump being direct-driven from the engine; and the auxiliary pump, hand-operated for filling the carburetors when first starting. Positive lubrication is provided by oil under pressure.

There is also an auxiliary gas-electric set, the function of which is to furnish power for lighting the cab, headlights and train coaches, and for pumping an initial charge of air to fill the tanks and start the main engines.

Mounted on the axles with nose suspension are 4 600-v., series, commutating pole, oil-lubricated, box frame, railway motors having an hourly rating of 100 hp. each and ventilated by a special vacuum system in conjunction with the engines.

Control of the motor equipments is similar to that of the standard gas-electric motor cars. Two motors are, however, connected permanently in parallel and these 2 pairs, operated like single motors, are placed progressively in series and parallel. The controller provides 7 running steps in series and 6 in parallel, without rheostats in the main circuit. There are also 2 additional points for shunting the series fields, making a total of 15 efficient running points.

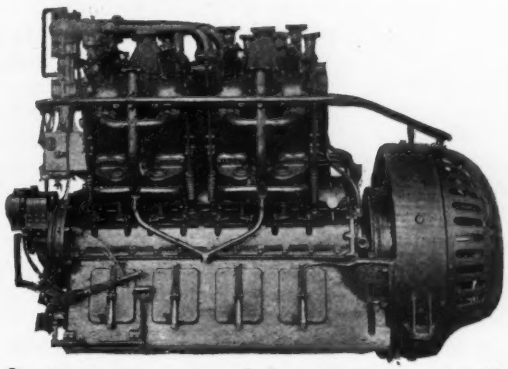


FIG. 2. OPERATING SIDE OF 2 8-CYLINDER, 4-CYCLE 600-V. GASOLINE-ELECTRIC GENERATING UNITS

Inasmuch as electrical energy is transmitted directly, there are no losses through the intervention of mechanical change-speed gearing. To produce smooth and rapid acceleration, the speed changes of the motors are effected by governing the voltage through varying the strength of the generator fields, which is accomplished by the movement of one handle on the controller. Separate handles are provided for throttling the engine and for reversing the motors. The latter is accomplished instantly by changing the motor connections in the usual manner, without stopping the engines, which always rotate in the same direction.

AN INTERESTING EXPERIMENT is now under way at the sulphur-mining plant at Bryan Heights, near Freeport, at the mouth of the Brazos River in Texas. The purpose, as mentioned in a recent publication of the Geological Survey on "Sulphur, Pyrite, and Sulphuric Acid," is to effect a large economy in the heating of mine water. Starting with the fact that the normal temperature of the ground water in the geological formation is 105 deg. F. at all seasons of the year, it is proposed to substitute this for the water now delivered to the plant for heating, the temperature of the latter varying with the season from 40 to 90 deg. F. The raising of the latter water to a temperature of 336 from 40 deg. F. obviously consumes much more fuel than to raise it from 105 deg., and advantage will be taken of this. The ground water, however, contains scale-forming substances, and special equipment has been designed to prevent the precipitation of this scale within the heaters or piping.

Oil-Filled Electrical Apparatus

REQUIREMENTS FOR SATISFACTORY OPERATION; PRECAUTIONS TO AVOID EXPLOSIONS

IN the early days of the development of the electrical industry, and particularly of electrical-energy transmission, the opening of high-tension air switches was a series undertaking and was avoided whenever possible. When an occasion arose demanding the opening of such a switch it was customary to assign 2 men for the work—one to pull the switch open and the other, equipped with a wooden pole, to knock out the arc between the switch points. At that time the words "high tension" did not have the same significance as that associated with the term today. Comparatively low potentials were in use, requiring small-capacity distribution and transmission apparatus, as judged by present-day conditions. Increasing pressures and current-carrying capacities have made necessary the design and construction of protective devices of corresponding capacities. Before transmission systems of 50,000 to 150,000 v. could be placed in operation it was necessary to find a material having greater dielectric strength than air, in order to insure circuit breakers, switches, and transformers against injury. Mineral oil complying with certain specifications has the requisite dielectric strength, and at the same time does not interfere with the working of the apparatus, so long as care is exercised in testing the oil and inspecting the apparatus.

We have heard of oil switches and transformers that have been in constant use for over 3 yr., with neither the apparatus nor the oil showing any evidence of deterioration at the end of that time. These must be considered as exceptional cases, however, because oil-filled electrical apparatus, and the oil itself, will ordinarily fall short of the original specifications after a comparatively brief time, unless carefully maintained. Since oil-filled apparatus is installed for the purpose of protecting the electrical equipment and thus reducing the interruptions to service to a minimum, it is of prime importance to understand just what causes breakdowns and how to guard against them.

In the case of a transformer, assuming that it has been properly designed and constructed, it is decidedly to the advantage of the user to see that the oil fully meets the specifications. He should make sure that the oil will be neutral in its reaction, and that it will not attack the insulation about the transformer coils. It should not become acid, nor precipitate any kind of solid matter, when heated for a long time. It should have good insulating qualities and at the same time should not volatilize, nor burn easily, nor be very viscous. Great care must be exercised to secure a mineral oil that will come up to these requirements, and even greater care is needed to maintain the oil in standard condition. Most mineral oils contain a small quantity of solid matter in a gelatinous or colloidal solution, and electrical stresses tend to separate these solid in suspension in the oil. Lead oxide in the varnish and lead alloys in the transformer lining are attacked by the oil, with the formation of a sludge. The sludge and the solids in the oil are quite likely to clog the ducts and effectively prevent the circulation of the oil through the windings. Wherever the circulation of the oil is interfered with or is checked entirely, local overheating takes place, damages the oil and tends to generate gases—particularly hydrogen. The temperature of the oil in the tank as a whole may not have risen to a point where prudence demands shutting down the apparatus, and yet local overheating may be constantly damaging the transformer and the oil until an explosion or a breakdown occurs.

An arc or a number of arcs below the oil surface will generate gases (consisting mainly of hydrogen and various hydrocarbons), which quickly make their way to the surface of the oil; and unless some means of escape is provided for them, each successive arc will add its quota of gas until a disruptive pressure exists. To avoid the possibility of such a condition gas vents or ducts are provided, which readily permit the gases to escape. There is the possibility, due to disturbance on the transmission lines or to switching operations, of a number of successive arcs being formed, each one generating gases which become mixed with the air above the oil surface. If, on account of one of the arcs piercing the oil to the surface, or because of the corona on the conductors above the oil, or because of an open flame existing near the gas vents, the mixture of gas and air is ignited, a disastrous explosion may follow. It seems hardly conceivable that workmen who are familiar enough with electrical work to be permitted to inspect transformers will use an open flame for a light, and yet this has often been done, and fatal explosions have resulted.

The oil used in oil switches should conform to the same specifications as transformer oil, with the exception that its flash point should be materially higher, and that more rigid limits should be prescribed for its viscosity. This latter point is very important, because if oil is used that readily becomes viscous the operation of the switch is hindered. We have seen switches in service with the oil having a consistency of partly-melted lard. Such a composition retards the opening of the switch, and moreover will not readily extinguish the arc.

The aim of the manufacturers is to arrange the mechanism of the oil switch so that it will operate as the potential wave passes zero. It is at this point that the arc may be most readily broken or suppressed. The arc may be re-established at the successive high points of the wave until such time as the contacts are far enough apart for the dielectric to prevent further arcing. It is generally thought that the oil flows in behind the arc and thus suppresses it, but there is some reason to believe that the gases also have an influence in suppressing the arc. The gases reaching the oil surface become mixed with air, so that if a succeeding arc should pierce the oil to its surface it would ignite the gases and cause an explosion, as already described in connection with the transformer. It is, therefore, essential to have a definite quantity of oil above the point of formation of the arc, in order to reduce as far as possible the chance of explosion.

Another cause of oil-switch explosions is lack of room for the expansion of the gases. Safety demands that the switch be of a size to contain enough oil to prevent the arc reaching the surface, and provision should be made for the escape of the gases. Unless this is done a succession of arcs, brought about by some electrical

disturbance, is likely to cause considerable damage to the apparatus, and to involve near-by workmen in danger.

It seems hardly necessary to speak of the deleterious influence of moisture in the oil of transformers and switches. A half-dozen drops of water per quart of oil will reduce its dielectric strength ⅓ or more. It is necessary, therefore, to provide oil having a dielectric strength sufficient to withstand several times the strength required for ordinary operation; and, in addition to this, frequent inspections and tests should be made, and whenever the presence of water is indicated the oil should be dehydrated by passing it through a filter.—The Travelers Standard.

Foreign Development in the Power Plant Field

"Salted" Carbons for Arc Lamps; Electrolytic Iron. By J. H. Blakey

RECENT improvements in incandescent lamps have stimulated the efforts of manufacturers of arc lamps to turn out an improved form of carbon. The result is the so-called "salted" carbon, produced by the firm of C. Conradty, of Nurnberg (Nuremberg), Bavaria, and described in the Elektrotechnische Zeitschrift. The positive consists of a tube of homogeneous carbon, A, surrounded by a jacket, B, formed of a mixture of salts containing fluoride of calcium, tungstate of sodium and chromate of potassium. This jacket of salts around the carbon retards its consumption without diminishing, but rather increasing the length of the light. The negative is an ordinary homogeneous cored carbon, the composition of the core differing only slightly from the normal.

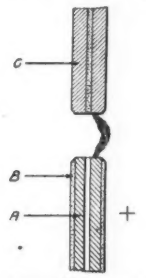
The arc burns quietly when springing from any point on the positive, even from points at a distance from the illuminating salts. The enhanced lighting effect is produced mainly by the formation of a kind of coating on the ends of the carbons, these being continually moistened by the molten salts which are fed to the poles in ample quantity. There is no accumulation of residue from the salts during operation. The carbons, in order to obtain the best results, must be burnt in a vertical position. A special lamp called the "Celdia" has been made by the firm of Korting and Mathiesen, of Leutsch-Leipzig, for use with these carbons. This lamp burns 40 to 50 hr. with one pair of carbons, at an efficiency of 0.14 watt per hefner-candle (one hefner being equal to 0.88 British candle) with continuous current, this including the losses in resistance.

Electrolytic Iron

Some time ago experiments were conducted on a rather extensive scale in Europe on the properties of chemically pure iron, produced electrolytically. The electrical and magnetic properties of this iron were found to be such that attempts have been made to produce it industrially. These attempts have been successful in the case of the Societe le Fer, of Grenoble, France, which has just taken out a patent for its method of manufacture. This process, starting with a crude iron of any chemical composition, produces an iron containing traces of carbon, silicon, sulphur and phosphorus in respectively 4, 7, 6 and 8 thousandths of one per cent, in the form either of flat plates or tubes.

The principle consists in the employment of a revolving cathode, a solution of ferrous salts maintained neutral by circulation of the liquid over iron turnings, and in the periodical addition to the electrolyte of a depolarizer, such as oxide of iron, which serves to carry off the hydrogen deposited on the cathode. With regard to the composition of the product, the above figures indicate the proportion of elements other than iron in an average specimen, but a guarantee can be given that the proportion of phosphorus will not be greater than 0.01 per cent.

The metal, on coming out of the electrolytic bath, is hard and fragile, as if hammer hardened, and contains a certain amount of hydrogen and carbon dioxide. Annealing for about 10 min. at a temperature of 1650 deg. F. permits the escape of the gas and softens the metal, which is then so ductile that it has been bent as often as 12 times without causing rupture. Its Brinell hardness numeral is 90*; its tensile strength 42,600 to 45,400 lb. per sq. in., and its elongation 40 to 43 per cent. Its hysteresis loop or cycle is very small and its magnetic permeability high.



"SALTED" CARBONS

The metal is obtained in tubes by the deposit of the iron on a revolving cathode; their length may reach 13 ft., with a diameter of from 4 to 8 in. and thickness of from 0.04 to 0.25 in. The thickness of metal is very regular, whatever the length of the tube, a valuable quality which has heretofore been impossible to attain in thicknesses less than 0.25 in. They resist considerable pressure; thus, a tube of 4-in. diameter and 0.03-in. thickness which was subjected to a pressure of 1135 lb. per sq. in. took on a regular permanent deformation similar to that produced by the action of a die. In general, they can be submitted to considerable deformation without any appearance of cracking.

With regard to the value of electrolytic iron for the manufacture of electrical appliances, the following figures give the results of the most recent experiments. For transformers the new metal gives a value 30 to 40 times as great, for equal weights, as the iron commonly used; for direct-current machines, a gain of 16 per cent; for alternating-current machines the power capacity is about 50 per cent greater. In addition to its use for electrical purposes, the new metal will probably be much employed in the manufacture of special steels on account of the uniformity of its composition.

*In the Brinell test, a hardened steel ball 0.39 in. in diameter is forced into the specimen under a static pressure of 6615 lb., and the depth of the indentation is found by means of a gage. The "hardness numeral" is computed by dividing the load by the area of the spherical surface in contact. Experiments indicate that the hardness numeral is directly proportional to the tensile strength.

Small Turbine Gives Exceptional Regulation

RESULTS OF TESTS OF WAIT TURBINE IN LUMBER EXCHANGE BUILDING

IN the June 1 number appeared a description of the power equipment in the Lumber Exchange Building.

At the time that article was written no tests had been run on the turbine generating unit, but the details of construction were described.

Since then, however, complete tests have been run and the unit has seen service under operating conditions in the plant and we are now able to give more information regarding its operating characteristics.

EFFICIENCY TESTS OF TURBINE IN LUMBER EXCHANGE BLDG.

	100 kw. on one Nozzle.	Maximum Load on one Nozzle.	Full Load on two Nozzles.
Time	1:49 A. M.	1:42 A. M.	1:56 A. M.
Volts	234	218.5	230
Volts corrected	234.2	218.5	230.1
Amperes	423	570	1000
Amperes corrected	423	572	1006
Kw. corrected	99	125	231.5
R.p.m.	2200	2175	2100
Number of nozzles	1	1	2
Temperature at Throttle, deg. F.	404.5	400.3	
Pressure at Throttle, lb.	140	139	134
Pressure at Throttle corrected	140	139	133.9
Pressure at Nozzle, lb.	112	137	125.5
Pressure at Nozzle, lb., corrected	112.15	137.5	125.8
Back pressure, inches of Mercury	.23	.25	.55
Lbs. per sq. in.	.11	.12	.27
Steam consumption. Lbs. per kw. hour. Actual conditions	48.5	45.7	
Approx. Check. Estimate on assumption (incorrect) that steam is sat. at noz. entrance.	48.6	46.2	46.1
Efficiency of set, as compared with perfect heat engine	39.6%	41.8%	45.5%

SUMMARY OF HEATING RUN

		Commutator.	Armature.			Fields		
		Hottest Part	Core	Winding	Duct	Air From	Shunt	Series	Int. Pole
Rise after 2½ hr. run at miscellaneous loads	C°	39.5	23	6		12	19	13	12
	F°	71	41	11		22	34	24	22
Rise after 5 hr. run at 100 kw. following above	C°	24	15			6	21	9	6
	F°	43	27			11	38	16	10.5
Rise after 2½ hr. run at 133 kw. following above.	C°	22.5			16	6.5	22		5.5
	F°	41			28	12	39		10
Rise after 2½ hr. run at 150 kw. following above.	C°	32	17			8	21		11
	F°	58	30			14	37		20
Rise after 1 hr. run at 300 kw. following above	C°	48	34.5			15	26		36
	F°	86	62			27	47		65

This turbine was not installed with the expectation that it would be economical of steam per kilowatt-hour, but principally because of the small amount of space it occupies and to be used as a steam pressure reducer during the light load periods when heat is required for the building. So far it has come up to every expectation and while the requirements of voltage regulation are severe, owing to the electric elevator load, no perceptible variation in voltage is noticed on the lamps. The results of several tests are given herewith.

REGULATION TEST

With 60 kw. load on the generator switching on an additional load of 55 kw. caused an instantaneous drop of 1 v. (due to resistance, etc., in dynamo), then a slower drop of 3 v. (due to speed). The voltage then rose slowly to 1 v. above normal and gradually came back to normal. Throwing off this load caused practically the reverse cycle.

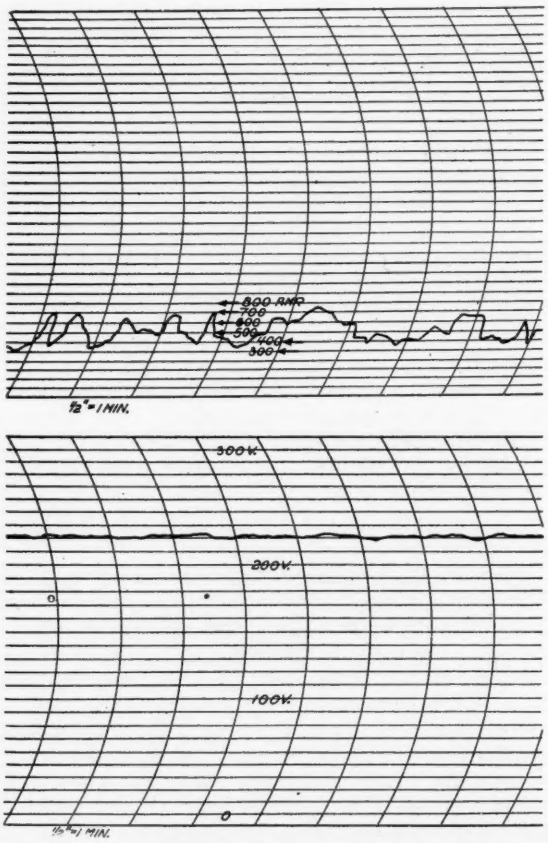
The variation was practically the same at whatever initial load point the variable load was thrown on or off.

A change of load of 60 kw. caused a momentary variation of 40 revolutions (2 per cent) in the speed, and a change of 110 kw., 50 revolutions (2½ per cent) in the speed.

SPARKING

Brushes in fixed position at all loads.

Occasionally during run "pin sparks" occurred at some brushes especially at the larger loads these soon disappeared. At loads of 1000 to 1300 there was more or less general sparking of the fine blue "non-cutting" character.



REPRODUCTION OF RECORDS FROM RECORDING AMMETER AND VOLTMETER SHOWING VOLTAGE REGULATION

The illustration is a reproduction of sections of records taken from recording ammeter and voltmeter which shows clearly the wide variation in load and the comparatively slight changes in voltage. These records were taken under normal operating conditions as they will be met by the turbine unit.

THE COLLEGE OF ENGINEERING of the University of Illinois opens its new year with an attendance of 1184 in the Under-Graduate Department of the college, including 259 students of Electrical Engineering, and 238 of Mechanical Engineering, these 2 being the largest branches in the college.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Development of Crude Oil Engines*

THE DIESEL SYSTEM, AND ITS MODIFICATIONS, FOR THE USE OF CRUDE OIL; HIRSCH ENGINE; REMINGTON OIL ENGINE; BRONS-TIMMER ENGINE. BY SAMUEL M. HOWELL

THE engines so far considered are all of the mixed compression type; that is, the air and the fuel are drawn into the combustion chamber together and compressed as a mixture; but in the Diesel engine the air drawn into the cylinder by the outward movement of the piston, or otherwise introduced, is compressed on the return stroke to at least 500 lb. per sq. in. As the crank is turning the center, the fuel pump operating at a still higher pressure begins to inject a spray of oil fuel which is instantly and automatically ignited by the self-produced heat of the air charge, and the injection of fuel continuing for a fractional part of the stroke, the piston goes forward propelled by the power thus generated. This invention now known the world over was one of the great events in the evolution of the internal combustion motor, and the engines have long been constructed by a number of leading firms in Europe, and also to some extent in the United States; but certain difficulties arising partly from the very high pressures employed, caused the introduction of some modifications of the original system, aiming to secure an equivalent effect with lower and more controllable degrees of pressure; and led to the development of the semi-Diesel or hot bulb engines; and these designations now apply to a large class of improved designs; in fact, about all of the recently patented oil engines come under these definitions, as they are fundamentally Diesel engines in which the details of construction and operation are variously modified; but the compression pressures used in these later designs are far too low to insure the ignition of the charge without auxiliary means; and this is accomplished in most cases by the addition to the combustion chamber of a globular or hollow bulb-shaped appendage of metal, so disposed that it becomes quite hot and remains so, effecting the prompt ignition of the injected fuel.

This arrangement generally extends beyond the cylinder wall in a position to be conveniently heated by a torch, as a preliminary operation in starting. In some

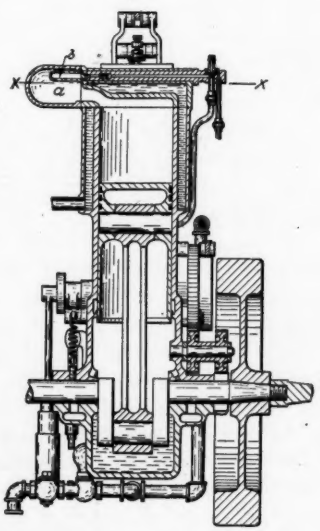


FIG. 1

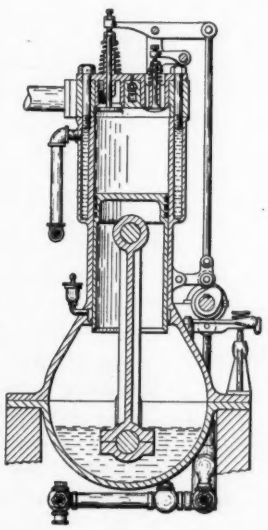


FIG. 2

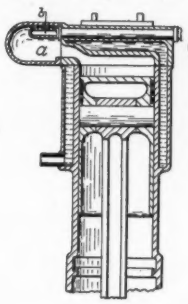


FIG. 3

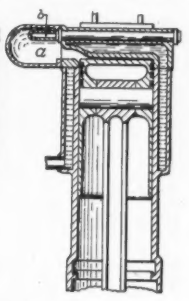


FIG. 4

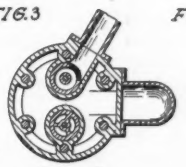


FIG. 5

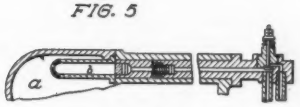


FIG. 6

FIG. 1. VERTICAL SECTION OF HIRSCH ENGINE COINCIDENT WITH SHAFT

FIG. 2. VERTICAL SECTION OF HIRSCH ENGINE AT RIGHT ANGLES TO THE SHAFT

FIG. 3. POSITION OF PISTON AT OPENING OF FUEL VALVE

FIG. 4. PISTON AT INWARD EXTREMITY

FIG. 5. HORIZONTAL SECTION OF CYLINDER HEAD

FIG. 6. SECTION OF IGNITION CHAMBER

*Continued from page 970, Oct. 15 issue.

cases, however, a metal plate or other equivalent of the bulb as an igniting means is contained wholly within the combustion chamber, and in this event a spark plug or hot tube must be used for starting. When once started the heat of this part maintained by the operation of the engine will continue to fire the charges with perfect regularity; and since the time of ignition is controlled entirely by the injection of the fuel, pre-ignition from undue compression, or an overheated head can never occur.

The Diesel system in general lends itself very conveniently to the 2-stroke principle, and many 2-cycle engines of this character are now in use, while others are 4-cycle.

In the literature of this subject the terms semi-Diesel and hot bulb are often used indiscriminately;

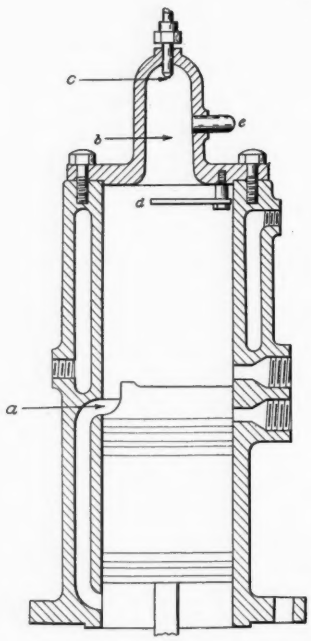


FIG. 7. REMINGTON OIL ENGINE

but in other cases semi-Diesel refers only to those engines in which gradual combustion takes place, as in the original system. For the sake of convenience, those of this general class which are ignited by means enclosed within the combustion chamber may be called semi-Diesel, while the others are hot bulb engines; as a matter of fact, however, both are semi-Diesel.

Hirsch Engine

A NOTABLE INSTANCE in the modification of the Diesel system was the invention of the Hirsch engine, patented by F. C. Hirsch, April 4, 1899, No. 622,469. This patent is one of the earliest in the hot bulb air compression class, and is the prototype of many subsequent designs. Figure 1 is a vertical section of the engine on a plane coincident with the center of the shaft. Figure 2 is also a central vertical section, but at right angles to the shaft. Figure 3 is a sectional view showing the position of the piston at the moment the fuel begins to enter the combustion chamber, and Fig. 4 is a similar view, showing the piston at the extremity of its inward movement. Figure 5 is a horizontal section of the cylinder head on line x-x in Fig. 1. Figure 6 is an enlarged section on a vertical plane of the ignitor chamber and its component parts.

The engine is 4-cycle, and the operation is as follows: The bulb *a* having been previously heated by a gasoline torch, the air drawn in on the outward stroke is compressed by the return movement of the piston. When the latter has reached the point shown in Fig. 3, a charge of oil driven by the fuel pump begins to enter the bulb through the small holes in the extremity of tube *b*, and continues to do so until the piston arrives at the end of its stroke. In this interval the oil mingled with the air of the charge has been gasified and fired, by the combined heat of compression and that of the bulb. At the termination of the power stroke the spent gases are discharged as usual by way of the exhaust valve.

The distance traversed by the piston while the fuel is entering the bulb as shown in Figs. 3 and 4 is equal to 1/10 of the entire stroke, and this measured on the crank circle equals at least 36 deg., or 10 per cent of the

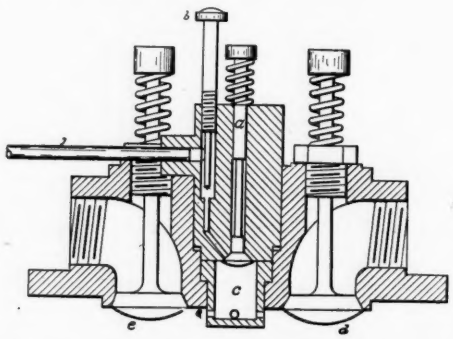


FIG. 8. CYLINDER HEAD OF BRONS-TIMMER ENGINE

revolution, and making a further allowance of the same angle on the other side of the center, we have 20 per cent of the entire revolution as the interval for the burning of the fuel, and the generation of pressure. This gives sufficient time for complete combustion and leaves 1/10 of the stroke for the development of power. The additional back pressure produced during the last tenth of the compression stroke is very slight, as this part of the movement is largely consumed in the introduction of the fuel, and is preliminary to the generation of maximum pressure.

The Remington Oil Engine

THIS ENGINE, patented by Wallcot Remington, March 1, 1910, No. 951,093, is of the 2-stroke semi-Diesel class, using only a moderate degree of compression, and is self-igniting. The principle of its operation is stated by the inventor, as follows:

After a series of experiments, I have discovered that perfect combustion of the oil or other fuel may be obtained by compressing air, or air and water vapor to such a degree that its temperature is above that necessary for vaporizing the fuel, but below the temperature at which the fuel ignites, and injecting the oil into the

compressed air in such a manner that it passes through it, is vaporized thereby, and then comes into contact with a heated surface remote from the point of injection, the temperature of which surface is sufficiently high to ignite it.

The construction shown in Fig. 7 illustrates this manner of operation. The air entering the cylinder at the termination of each outward movement of the piston by way of the admission port *a*, is driven by the return stroke into the dome *b*, and as the crank is turning the center a fuel pump operated from the shaft injects a charge of oil fuel from the nozzle *c*. This is gasified by the heat of the air within the dome, and fired by contact with the ignitor *d*. The latter (in the present instance) is a flat-shaped steel plate about ⅛ in. thick, and an inch or less in width, secured at one end to the cylinder head just below the base of the dome, and extending part way across it directly in the path of the injected fuel; *e* is a tube to be heated for starting.

Engines of this character, but differing in details from the above, are manufactured on a large scale, and are favorably and widely known.

The Brons-Timmer Engine

Patented originally by Jan Brons and Nanno Timmer of the Netherlands, Oct. 22, 1907, No. 868,839 (U. S.). This is a Diesel cycle oil fuel engine in which the fuel charge is drawn into the combustion chamber simultaneously with the inspiration of the air, on the suction stroke of the piston, through a simple valve of small size, and ignited at the proper instant by the heat of compression, without the use of a fuel pump or an igniting member. This invention created a great deal of interest, and received much attention from the engineering profession. It was, in fact, a notable step in the further improvement of the Diesel system.

The operation of this engine involves an initial or previous explosion of a small part of the injected oil charge, by which the remainder of the fuel is atomized and blown out into the main body of the combustion chamber, where it mixes with the air charge, and is consumed on the power stroke. In the language of the inventors, the arrangement is "in a 4-cycle internal combustion engine, a process of operation characterized by the introduction of the liquid fuel during the suction stroke, into a chamber that is in open connection with the combustion space of the power cylinder, part of the fuel being gasified within said chamber, the gas thus formed entering the combustion space, and being ignited near the end of the compression stroke; the remaining fuel is thrown out of the aforementioned chamber by the force of the explosion and injected into the burning mixture."

The cylinder head shown in Fig. 8 is an embodiment of this principle. The drawing is a section divided on 2 parallel planes, one passing centrally through the fuel valve, and the other, more remote from the observer, bisects the exhaust and air admission valves; *a* is the fuel valve, and *b* is a needle valve by which the quantity of the supplied fuel is regulated.

As shown here, this needle valve is operated by hand, but otherwise it may be controlled by a governor. The fuel valve and also the air admission and exhaust valves are operated from the shaft. The fuel is admitted to the chamber cup *c* on the suction stroke, and is thrown out through the holes at the base in the manner described above, as the piston nears the end of the compression stroke; *d* is the air admission valve, *e* the exhaust valve, and *p* the oil fuel supply pipe.

This method of fuel introduction has been adopted by several manufacturers, and is now known as the pre-explosion principle. The system requires a compression pressure of 500 lb. per sq. in., but like the original Diesel engine is very economical in the use of fuel.

The De La Vergne, the Bessemer, the Muncie, the National, and several other well-known oil engines now on the market are of the modified Diesel type, in which a lower degree of compression is assisted by a heated member, usually a bulb, to ignite the charge, and these with the exception of the first named are 2-cycle. The Bessemer is both 2 and 4-cycle. The Snow is a high compression engine of the full Diesel class. It is also either 2 or 4-cycle.

The St. Marys is also a high compression engine receiving the fuel charge by the pre-explosion method before described. In this case, however, the fuel chamber is closed by a valve. This places the final admission under positive control, and is a further improvement upon the original method of Brons and Timmer. The compression pressure employed in the De La Vergne engine is 280 lb. per sq. in. In the Bessemer it is 180. In the Snow it is 500. Any of those named will operate upon low grade fuel oil, and all are manufactured by firms of high commercial standing.

(To be continued.)

Convertible Combustion Engines*

Modifications in the Construction of Internal Combustion Engines Fitting Them for Use with Various Kinds of Fuel. By A. E. L. Chorlton

Advance in the use of the internal combustion engine for all duties becomes yearly more marked; and in the last decade, particularly the latter 5 yr., it has been almost phenomenal, as exemplified by engines of the higher compression type, using fuel oil, the conveniences in the use of which are so noteworthy that they are bound to claim serious consideration in almost all cases, even where coal is the basis fuel.

In the normal engines, for both gas and oil, the chief difference lies in the degree of compression. Thus the compression of a modern gas engine using coal as its basis fuel may vary from 90 lb. per sq. in., when using coke-oven gas, to 150 lb. per sq. in. for producer gas (and even higher if waste gases are used from blast furnaces); while for the liquid fuel engine, using crude or residual oils, the compression pressure may exceed 500 lb. per sq. in., as in the case of a Diesel engine using tar oil, but may be considerably less if the temperature of ignition is obtained by uncooled surfaces, or auxiliary or pocket firing used.

*From a paper read before the Institution of Mechanical Engineers.

As there is no fundamental difference in engines for gaseous or liquid fuels, except in their conventional cycles, it follows that any schemes of convertibility must provide means whereby the requisite compressions can be readily obtained; but, as between 500 lb. and 150 lb., there is a great gap, the tendency is, for practical reasons, to combine the lower compression oil engine and the higher compression gas engine, and thus deal with a smaller compression pressure range. The problem is mainly a mechanical one, in and around this change of compression, and a combination from a judicious selection of well known types which have proved successful with their various fuels.

Though the convertibility may be affected somewhat by the cycle—that is, whether 2 or 4—it may be taken generally that the degree of compression is the governing factor. The desirable characteristics of the convertible engine are: Simplicity and reliability; economy should be high for each fuel; first cost as little as possible above that of the standard engine for each fuel; easy convertibility; as near as possible the same power developed for each fuel.

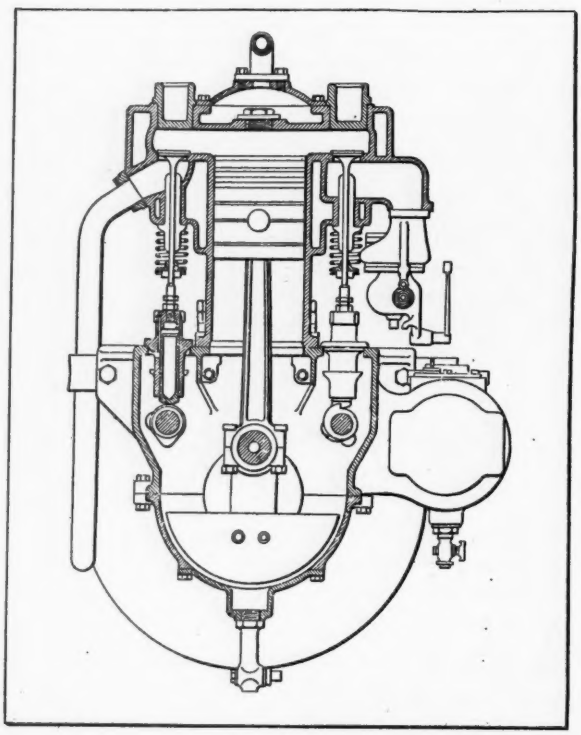


FIG. 1. DIAGRAM OF ORDINARY MOTOR CAR ENGINE USING VARIOUS FUEL

Consideration of the subject may be more clearly undertaken by dividing the types of engines in use into 3 groups, with further subdivisions due to peculiarities of design:

1. Engines of low compression and low power.
2. Engines of high compression and higher power.
3. Engines of medium compression and higher power.

As an example of the first group we may take the ordinary motor car engine, Fig. 1, having a compression up to 90 lb. per sq. in., and which, with slight modifications, will run on:

(a) Petrol or benzole.

(b) Good paraffin, with an exhaust heated carburetor.

(c) Town gas.

(d) Producer gas made from coal or waste combustible material.

It is designed for, and works best on, petrol; fairly well, however, but not so economically, on town gas; it requires very good paraffin, and is not efficient at the low compression with producer gas.

To go further and extend the range of fuels, to use a commoner paraffin or a good brand of crude oil, means must be provided whereby more heat is available for the ignition and combustion of the oil, and this can be conveniently done by the addition of an unjacketed portion to the cylinder end, when the engine becomes of the hot-bulb type. A change of parts for such an engine does not present any difficulties, and these can readily be made to give with any adjustments of compression necessary for the producer gas with the greater heat required for ignition and combustion of the oil. The gas fittings are provided with electric ignition, also suitable when petrol is used, while the paraffin and good crude oil would be self-ignited by the hot bulb. Figures 2, 2A and 2B, illustrate the practical application of these modifications. The engine illustrated was lately built with success to work on all usually available fuels, for small powers, and such a type can be changed by unskilled labor from a gas engine working with a wood or coal producer, to an oil engine using a good brand of Russian crude oil, the governor requiring no adjustment for the full range of fuels. A comparative commercial table of the results obtained with this engine is:

	Compression lb.	Maximum Pressure lb.	M.e.p. lb.	B.t.u. per B.hp.-hr.
Paraffin oil....	55	210	58	14,500
Producer gas..	90	230	65	12,000

Figure 2 shows the gas or petrol engine with electric ignition, also the oil engine, a hot bulb being added in the latter case and ignition obtained thereby.

This type of engine is not suitable for any but comparatively low powers, and the range or fuels does not include one heavier than good crude oil. Further, its economy on oil is not high. It is mainly described here as it contains the basic principles of a more suitable engine for large powers. Further modifications must, therefore, be made in order that the fuels of poorer quality may be used, and this for any range of power. These conditions demand an engine having a considerably higher compression for the fuel and residue oils, and in the second group we have engines with high compression and higher power.

Group 2 is represented by the Diesel engine, with a compression of over 500 lb. per sq. in., when using tar oils, unless an ignition oil is used. As the maximum compression for gas (in the normally used type of engine) does not exceed 150 lb. per sq. in., it will be readily seen

that there are considerable mechanical difficulties in building an engine in which both of these compressions can be obtained, with a reasonable amount of modification. Further, the Diesel engine has an expensive high pressure air pump, which is unnecessary for the ordinary type gas engine.

Apart from the mechanical difficulties, we may compare the commercial possibilities of this type, the oil and gas sides being as follows for engines of the same cylinder dimensions:

	Compression	Abnormal Maximum Pressure	M.e.p.	Approximate B.t.u. per B.hp.-Hr.
	lb.	lb.	lb.	
Oil engine....	500	over 1000	100-110	8000
Gas engine.....	150	600	80	8500

These figures show how incompatible the 2 designs are, for they illustrate that the Diesel structure must be built twice as strongly for the high maximum possible pressure, due to the fuel valve sticking, etc. The higher mean effective pressure used is some compensation for this extra cost and weight. The mean cylinder pressures reveal a still further disadvantage when the gas conversion is considered, for there is, besides this high first cost, a reduced power, owing to working at a lower mean effective pressure, 80 lb. as against 100 to 110 lb. per sq. in. A convertible engine on these lines does not seem a commercial possibility. The cost of the air compressing part of the Diesel has not been considered, nor has the working of the gas engine on the Diesel cycle, for this alternative, at any rate at the present date, is not a commercial proposition. The net efficiency may be actually lower, due to the loss in the gas compression; and the risks of working greater. Although it is of the utmost necessity that any lasting type of prime mover must have in these days as its essential feature economy in fuel, it is still not the only point, for reliability and simplicity must be equally considered. While, therefore, recognizing the economy of the high compression self-ignition engine, we are compelled to look to one of the other types described as a more suitable combination for everyday use.

(To be continued.)

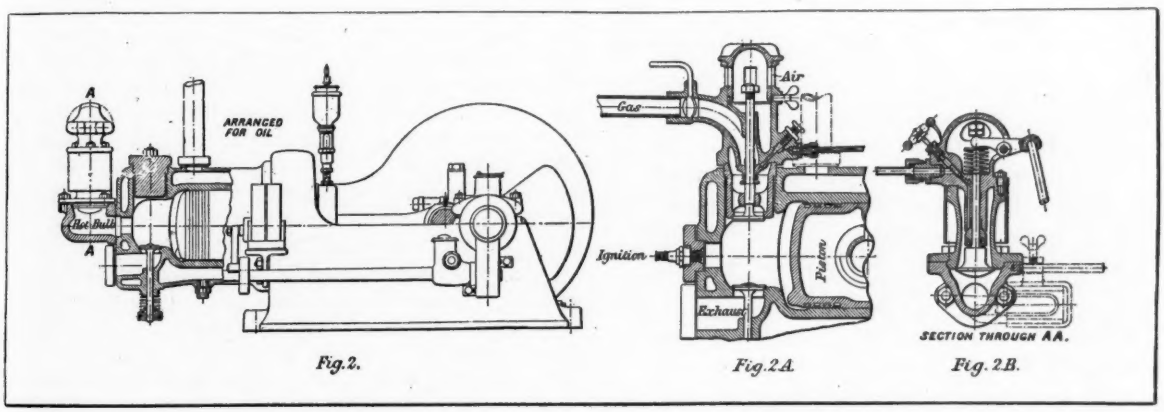


FIG. 2. CONVERTIBLE ENGINE FOR SMALL POWERS USING GAS OR LIQUID FUEL

FIG. 2A. ARRANGED FOR GAS OR PETROL
FIG. 2B. SECTION THROUGH AA OF FIG. 2

Telephoning by Wireless

TRANSOCEANIC COMMUNICATION AN ACCOMPLISHED FACT

THE wireless telephone has been a subject of much experiment, and of some exploitation in the investment field for many years. It has now been taken up and brought to a successful conclusion by the American Telephone and Telegraph Co., and while much experimental work and investigation will yet be necessary before long distance wireless telephone communication becomes a commercial proposition, the success achieved is sufficient to ensure that it is but a matter of time when the wireless telephone will be as common as is now the wireless telegraph.

From the government wireless telegraph station at Arlington, communication by wireless telephone has been had with San Francisco, Honolulu, the Isthmus of Darien and Paris, the talking qualities of the apparatus working perfectly and giving so clear enunciation that, at the Honolulu station, even the voice of the person speaking at Arlington could be recognized. This success makes it certain that wireless communication may be had across both the Atlantic and Pacific, as the distance from Washington to Honolulu is greater than the distance from Seattle to Yokohama, while the bridging of the Atlantic is an accomplished fact.

The success of this new development is due to the careful work and perseverance of the engineering corps of the American Telephone and Telegraph Co., headed by John J. Carty, and marks another step forward in the conquering of space and time by engineering persistence and ingenuity. Mr. Carty says that he can see no obstacle to the human voice encircling the globe when sufficiently powerful apparatus is available, and the obstacles which will be found as the system develops have been overcome.

WHEN A semi-Diesel engine, not using water injection, runs all right on fuel oil and knocks on kerosene, the compression is too high or the bulb is too hot. If the bulb is of the internally ribbed type, use a bulb with a smooth interior for kerosene.—The Gas Engine.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Priming of Stirling Boilers

IN REFERENCE to the query and answers in recent issues relative to the priming of Stirling boilers, I will add my experience. We operate 4 360-hp. and 4 509-hp. Stirling boilers, 6 being in operation at one time. Our load after it is on is steady; but at 6:45 a.m. and 1:00 p.m. we pick up 4200 kw., and our dye house and bleachery, and, of course, in the winter the heating for 10,000,000 cu. ft. of space is always on. These boilers have a water glass ¾ by 18 in. and the regulators are adjusted to cut off the feed when there is 4 in. of water showing. As the load comes on, the water will rise about 6 in., giving about 10 in. in the glass. The 4 360-hp. boilers will not prime under the most severe conditions unless the boilers are flooded from feed; this is due to their construction, as shown in Fig. 1. As the water rises in the front drum, assuming that the boiler is not flooded and that the water was foul enough and

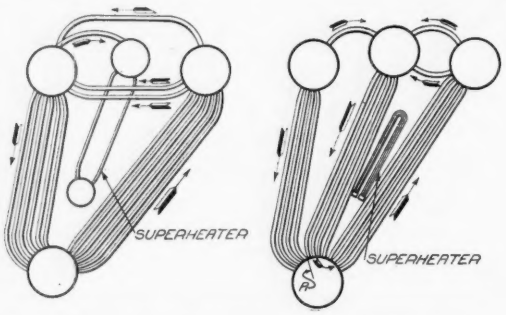


FIG. 1. TUBE ARRANGEMENT OF BOILER WHICH GIVES NO TROUBLE FROM PRIMING

FIG. 2. TUBE ARRANGEMENT OF BOILER THAT PRIMED

the rate of driving is great enough, it would pass with the steam over the cross steam tubes to the rear drum which would act as a separator and, as all the steam passes from this drum to the superheater drum, nothing but steam will pass to the superheater; under the most severe condition outlined below, I never saw a trace of water in the superheater drums. When the load is dropped, the water will drop from sight, but not so low that water will not come from the glass blowoff.

The construction of the 4 509-hp. boilers is different, being the standard 3-drum top construction and the B. & W. Co. superheaters, U-type, as shown in Fig. 2. The steam tubes are connected from the front drum directly to the center steam drum as are the steam tubes from the rear drum. A 6-in. pipe carries the steam from here to the U-tube superheater. These boilers will prime under severe conditions of water which is foul or if the water line is carried too high when there is a very light load on the boiler, and a heavy load is thrown on suddenly; under this condition, there should be not more than ½ glass of water if the boiler has been in operation without cleaning for some time.

These boilers had not been in operation more than one week when we had all kinds of trouble from priming; the surges were at times so violent that it would run the water up and lift the safety valves at a pressure of 5 lb. less than the regular blowing point, and the result was a heavy local shower.

We got a portion of our water from a pond in the yard and were using this water. Blowing the boilers excessive amounts gave little relief. We appealed to the B. & W. Co. and their representative made a number of trips to our plant. When these boilers primed, the alkali odor was very strong and I was at a loss to account for how it was possible that alkali in any such amount could be present. This condition existed for some time, giving trouble on the new boilers, but there was no ill effect on the older boilers.

One day while I was in the bleachery, they were opening barrels of soap used in washing yarns; one smell of that soap and I knew I had my friend. I asked the bleacher what became of the soap suds after they were through with them. They went to the sewer. I then asked him what became of the water used to rinse the yarn.

"Oh, that goes to the pond, as that is good pure water and should not be wasted."

I then told him what happened to the boilers.

"Impossible," he exclaimed, "that is pure soap and would have a bad effect on no boiler. Why, I shave with that soap."

I told him that might all be so, but that if he came to the station some time when one of those safety valves let go from a surge of water, he would be going too fast for some time to shave. This water was diverted to the sewer and, strange to the bleacher, our trouble was over.

During these troublous times I had constructed and installed a dry-pipe, but that afforded no relief whatever. This happened about 3 yr. ago and no further trouble has been experienced.

The dry-pipes have been removed; I could see no value in them, as they gave us no drier steam than after their removal and they were in the way when cleaning the boilers.

The B. & W. Co. representative at this time stated that at the plant where these boilers are built, they had made a test to see how heavy a draft of steam would be necessary to lift the water to the steam nozzle. With this in view, they fired a 500-hp. boiler up and drove the steam up rapidly to 175 lb. per sq. in. pres-

sure, had full draft on the furnace and opened a 6-in. valve placed directly on the steam nozzle to the atmosphere and there was no water lifted. They had a gage and one-half of water at the start and held the valve open until there was one 1 in. visible in the glass.

I think a distinct improvement could be made in the action of these boilers, as far as priming goes, if the steam tubes were carried from the front drum, Fig. 2, to the rear drum as in Fig. 1, then carried to the center steam drum which would make the rear drum act as a separator.

An improvement could be made in the prevention of scale in the front tubes if there were inserted in the mud drum a baffle as shown in Fig. 2 at A. The tubes entering the mud drum are nested so close together that the circulation, which is very rapid, up the front bank of tubes, carries water which is settling from the rear bank with its impurities, directly up the front bank of tubes to the hottest part of the tubes where it forms a very hard scale; the baffle would prevent this action.

In a plant operated as ours is, the feed water regulator is a positive asset due to the steady load. When the load comes on, the water rises and the regulators close which gives a chance to get the operation under good control for steaming; when feeding starts, the feed is constant, then when the load falls off, they will feed heavy helping to hold the steam pressure below the blowing off point. It is easy, however, to understand how, on a widely varying load, this action would be undesirable. GEO. F. WEATON.

Lessons Learned from a Working Model

AFTER EXAMINING a glass model of a horizontal return tubular boiler in actual operation of generating steam, a few previous ideas regarding the performance and operation of return tubular boilers were dispelled as incorrect.

The 2 events regarding the operation of this boiler that impressed me most were the sudden opening of the main stop valve and its effect, and the operation of the blowoff valve and its performance in regard to removing mud and sludge from the shell of the boiler.

When the stop valve was suddenly opened, there could be plainly seen the rush of steam to the opening. Mixed in with this steam were small drops of water that were lifted from the surface of the water in the boiler and carried out with the rush of steam. Here is one of the main causes of water hammer and its consequences in steam lines that were seemingly well drained and free from pockets.

Anyone having had the opportunity of observing this action in the boiler when the main stop valve was suddenly opened, will surely think twice before opening any main boiler stops in a hurry. This, by the way, is a common occurrence, and when the person doing so is brought to task for it, the excuse is generally given that the "line is warm and well drained and the traps will take care of any water that may get into the line."

When the blowoff valve on this boiler was opened and I noticed the effect, my opinion of ridding the boiler of sludge and mud by means of the bottom blowoff valve was somewhat changed.

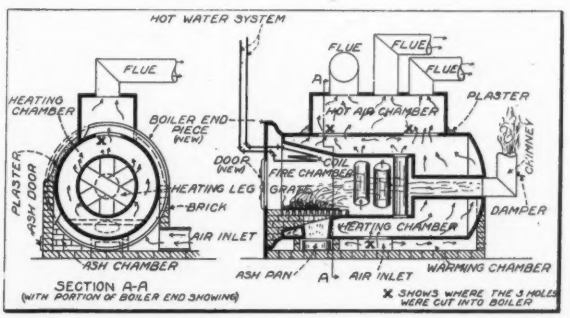
In the experiments with this model boiler, very little mud and sludge was removed from the boiler by means of the blowoff valve. When the blowoff valve was opened, a small space around the opening of the blowoff pipe where it entered the shell was cleared of mud and sediment. Opening the valve did not seem to have any effect on moving the mud and sediment lying on the bottom of the boiler near the bridge wall. Instead of the mud and water on the bottom of the boiler rushing to the opening when the valve was opened, as I had previously supposed it did, it practically lay dormant excepting the small amount that blew out around the opening of the blowoff where it entered the shell.

When the valve was opened, the water rushing down to the opening appeared and practically did come down from the surface of the water level in the boiler in a swirling funnel-shaped motion. This swirling motion was similar to the motion of water running out of a round bowl or wash basin when the plug was opened on a full basin of water.

Working models of boilers and machinery in general and valves, and valve gearing especially, are a source of excellent instruction to anyone interested in this line of endeavor. Any points brought out in regard to design, care and operation by means of these models are not easily forgotten. C. E. ANDERSON.

New Use for Old Boiler

IN THE drawing is shown a unique use for an old Scotch boiler. The boiler was taken out of a steamboat and was thrown on the wharf adjacent to where the boat used to call regularly. After the boiler had been left idle for some time, an ingenious man who had had trouble with the wearing out of his furnace, came along and got the boiler delivered at his house for practically nothing. He turned the boiler, which is of the vertical type, over on its side and had a couple of holes drilled



SCOTCH BOILER CONVERTED INTO HOT AIR FURNACE

in the casing of the water space, had a hot-air box and other arrangements connected to it, and thus transposed it into a hot-air furnace and connected with his old system. The old fire-door serves as the dump for the ashes. The drawing shows what was done, and what arrangements can be made if he later decides to use a hotwater system.

Comparing the furnace with an ordinary hot-air furnace, this new arrangement has many things in its favor; for instance, the fire space is large enough to take young

trees if they are at hand, and this saves a lot of chore-work. The plating is so thick that it will outlast about 10 ordinary furnaces, and it also serves to hold the heat so that the furnace will keep up its temperature and heating powers even after the fire goes out. The air space, being all around the furnace, cannot but be efficiently heated, and every part of the furnace is accessible to a great extent. A. P. CONNOR.

Repairing Connection of Steam Pressure Gage

THE NIPPLE by which the steam gage pressure pipe connects to the gage is frequently broken. The accident occurs commonly as a result of a drop or fall and sometimes through a too vigorous application of a wrench in drawing up the brazing collar or nut of the pipe.

After such an accident, it is often the practice to order a new tube casting, Fig. 1, as the nipple on most standard gages is a part of the casting itself. If the lengthwise cross-section of such a casting were examined, however, the practical method of repairing the gages as in Fig. 2, would, in the majority of cases, be readily apparent. There is plenty of stock in the casting for drilling it out deep enough to take a ¼-in. pipe

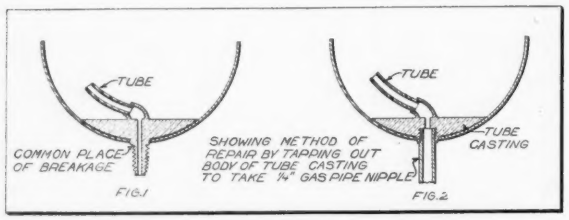


FIG. 1. TUBE CASTING OF STEAM GAGE
FIG. 2. METHOD OF REPAIRING TUBE CASTING

tap, after which a ¼-in. common gas pipe nipple can be screwed in and tightened up. This will afford in almost every case a connection for the pipe which can easily be made.

The writer was in a contract shop where a great number of gages were sent in for repair, and the breakage on 60 per cent of them was the one described above. The above method of repairing them was put into practice successfully, however, resulting in a much cheaper job, just as satisfactory and a quick return of the gage to the man who in 9 cases out of 10 did not have an extra one and was waiting for it.

F. W. BENTLEY, JR.

Method of Installing Pipe Under Tension

A PIPE line erected at 65 deg. and exactly 100 ft. long becomes something over 100 ft. 2 in. when under steam at 100 lb. pressure. Suppose both ends anchored and a U bend put in the center capable of taking care of that 2+ in. of expansion. When hot, the pipe line is under some compression; not much, it is true, but enough to spring each leg of the U bend in 1 in., which in a 6-in. or larger pipe would be several hundred pounds.

Then suppose 1 in. be taken out of each end of that main and when cold the U bend be spread apart 2 in.; that would take almost exactly the same force that it took to spring the ends together in the first instance, several hundred pounds, but easily within the strength of the pipe fittings and the U bend. Then, when hot, the bend comes back to normal, is under no strain except the pressure of the steam; when cold, you have 1 in. between any pair of flanges to make a joint without wedging the bend together.

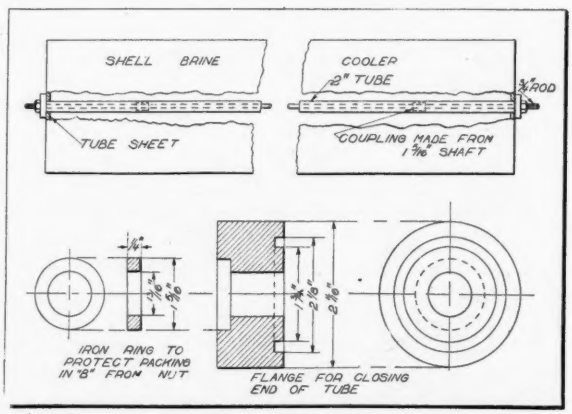
This method is not intended to replace bends or expansion joints, but is intended to work in connection with them (except stuffing-box expansion joints) to reduce the working strain in the bends and make it easier to replace leaking gaskets. I would use it on a line 1 mi., or 10 mi. long, and if it made a difference of length of several feet, I would need bends to take care of several feet, and when cold the bends would be spread apart instead of pushed together when hot.

HARRY D. EVERETT.

Repairing Leak in Brine Cooler

ACCOMPANYING sketches illustrate a method of repairing a leak in tube of submerged ice tank, shell brine cooler. The cooler lay across the end of a tank, so that at one end of the cooler, there was practically no room in which to work, while at the other end there was only 3 ft. 6 in. between cooler and side of tank.

The tube that was leaking was located by air pressure, brine having been removed from tank and ammonia connections blanked off. Two cast-iron flanges were made, as shown in sketch; ¾-in. rods, about 3 ft. long, threaded both ends, were inserted in tube, and coupled



METHOD OF BLANKING OFF COOLER TUBE

together by coupling, made of 1 5/16-in. shaft, 3 in. long. These rods were of a proper length, so that when coupled together, the ends would extend past the end of tube, to allow for flange and nut.

The groove A, in flange, was packed with gum sheet packing, placed over the end of tube. The recess B, was packed with ¼-in. steam packing, and the cast-iron ring was used as a gland to protect this packing from nut.

The cooler was tested to 200 lb. air pressure before it was put into service again. G. A. R.

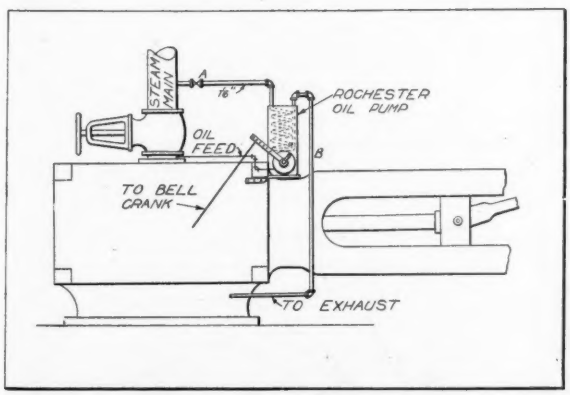
A Novel Stuffing Box

As I read the article entitled "Homemade Stuffing-Box Wrench," by N. G. Near, on page 975 of the Oct. 15 issue, I recalled an arrangement somewhat similar I came across several years ago on a tramp steamer. Among other things on that ship which attracted my attention was a geared stuffing-box. There were 6 studs (and of course the same number of holes in the gland), with 6 nuts, each nut being a small gear, and between each nut or gear was an idle gear thus allowing the 6 nuts to revolve together; all were driven by one master nut provided with an extension to receive a socket wrench.

When asked about this novel arrangement the engineer said it was not so very bad for taking up on the stuffing-boxes but when it came to the repacking of stuffing-boxes on an engine of this size and type,—that is, a 900-hp. vertical triple expansion unit,—it was a nuisance. Chas. M. Green.

Warming Cylinder Oil

A common trouble in feeding cylinder oil, especially where the oil has to be pumped into the cylinder, is that on winter mornings, especially Monday mornings, the engine room being cold, the cylinder oil is so thick that the oil pump will not draw, hence the engine gets no oil at a time when it should have the most, and I have known great trouble to be caused by dry steam valves, in drop cutoff engines, holding up the steam valve and blowing steam through.



METHOD OF WARMING CYLINDER OIL

The diagram shows a Rochester cylinder oil pump which is fitted with a 1/16-in. brass coil attached in steam main above the throttle and coming out at B and going to the exhaust line. The valve at A can be opened early before starting and the oil will be warmed so the pump will take it. A. C. Waldron.

Oil Separator Drips

Sometimes the engineer thinks that the drips from the oil separators in the exhaust line must be drained through a trap which discharges into the sewer, to prevent the loss of steam which might occur if the drain was left open. This, however, is not necessary where the pressure in the exhaust line is only 2 or 3 lb., or where a low vacuum is carried.

The accompanying sketch shows how this may be done. The loop should be below the level of the separator, to prevent flooding the separator, but need not be directly beneath it, and can be placed in any convenient location on the wall. The loop should be high enough to prevent the pressure or vacuum from breaking the seal. A column of water 1 ft. high has a weight of 0.434 lb. per sq. in., and if there is a pressure of 2 lb. in the exhaust pipe, the seal would have to be $2 \div 0.434 = 4.6$ ft. high to balance the pressure. It should be a little higher than this for good measure.

There is a drain siphon of this kind in our plant connected to the separator in the exhaust line to the feed water heater. Figure 1 shows how this is con-

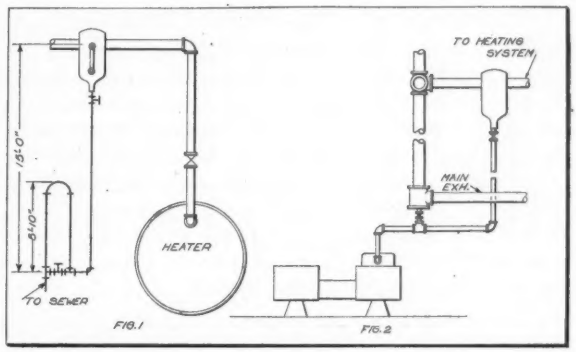


FIG. 1. USE OF SIPHON IN DRIP LINE
FIG. 2. PIPING USED WITH DRIP PUMP

nected up. The pressure in the exhaust pipe in summer when exhausting to atmosphere is about 1 lb. gage, and in winter when exhausting into the heating system it is from 2 to 4 in. vacuum. The length of the seal is 5 ft. 10 in. In this seal there is a bypass between the bottom of the drop leg and the drain pipe for the purpose of draining it should it become stopped up with sediment from the oil. In ordinary usage, the valve in the bypass is closed. In another part of the plant there are 2 10-in. separators in the exhaust line to the building heaters carrying the same pressure. In this case, the drip pipes are connected to a main drip pipe which is connected to the exhaust pipe drip pump located in a subbasement, and to which the condensation is drained by gravity. See Fig. 2. J. C. Hawkins.

Peculiar Experience with Graphite

At a bleachery in Worcester, Mass., the engineer ordered 100 lb. of graphite at a special price, after having been influenced by a salesman regarding its magic effect on scale. He diluted it in water according to directions, and without further thought fed it to the boilers.

An hour later, when the cover on one of the kiers was removed, the boss of that department thought his eyes needed treatment, or his optics needed radium. He wiped them twice with a clean cloth, dilated them, and decided to ask 2 other fellows in the room to come over and have a look at the thing that lay in the kier. It appeared like a huge elephant, rolled up, and sleeping. The fellows quickly disillusioned him; and he soon realized that it was the same cloth, indelicately beauti-

fied with mud. He immediately rushed to the fire room in search for the engineer, into whose ears he poured his grief. The engineer instantly realized it was the graphite.

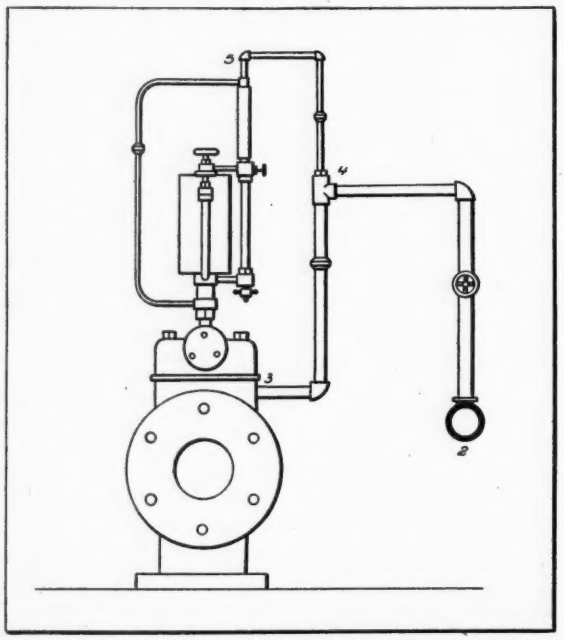
The superintendent got the news and hurriedly made a bee-line in search of the imprudent fellow upon whom he expended an impressive call-down. It is believed that engineer will give the subject a careful second thought next time before introducing graphite into his boilers when steam is used directly to boil cloth.

Before concluding, however, let me say that graphite is O.K. as a scale remedy, as long as no steam is used directly for manufacturing purposes from that boiler.

M. L.

Improving the Operation of a Lubricator

THE ACCOMPANYING illustration shows what was formerly a single-connection lubricator on a steam pump, but which now has 2 connections. The steam pipe, 2, was directly connected to the pump at 3 by a nearly straight pipe, and the lubricator was screwed into the steam chest. After steam was shut off from the pump, air collected in the lubricator connections; hence, when the pump was started again, no oil would go into the steam chest and cylinder, on account of the air, and no way was provided for disposing of it.



SYSTEM OF PIPING INSURING POSITIVE OPERATION OF LUBRICATOR

The small pipe carrying the throttle valve was carried vertically, as shown, but a tee was used at 4, instead of an ell. A ⅛-in. brass pipe was connected here, and joined to the top of the lubricator condenser at 5. There is no valve in this connecting pipe; hence, when steam is admitted, it divides at 4, part going into the pump at 3, the remainder passing into the lubricator at 5. This drives out the air and causes the lubricator to work without fail, as soon as the valves provided for regulating it are opened. As this pump requires a continuous supply of oil, although not a fast speed, to insure continuous operation, the change described is a great improvement. W. H. WAKEMAN.

Humidity and Leather Belts

WITH REFERENCE to the excerpts from an A. S. M. E. paper of the above title, published in the Oct. 15 issue of Practical Engineer, I have conversed with a number of experienced belt men on the subject since the above-mentioned paper was read, and the prevailing opinion is that Messrs. Bird and Roys are not quite explicit enough. From the paper, one is liable to think after reading it that *ALL* belts are affected by humidity. The first paragraph in Practical Engineer, for instance, reads:

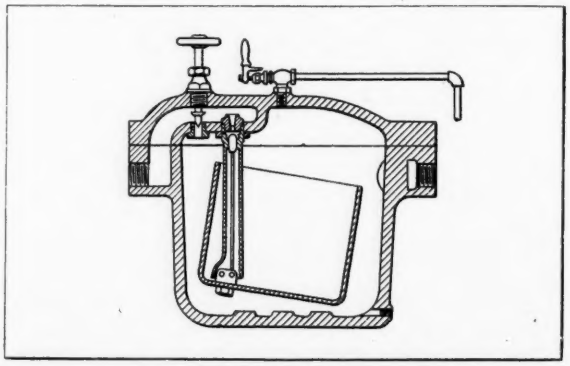
"That relative humidity of the atmosphere has a great deal to do with the efficient operation of oak tanned belts has long been recognized."

In discussions following the paper, it was pointed out that proper belt treatment will waterproof belts and make them immune to the whims of humidity. It has been my experience that treated belts do not lengthen or shorten, dry or harden, in cold or hot weather.

The tests are of value, of course, for the same reason that friction tests are sometimes considered of value between bearing metals when run "dry" (without lubricant). Yet, in practice, it is the custom to lubricate bearings, which virtually throws the friction tests onto the "scrap heap." I therefore consider the above belt tests of more "theoretical" value than anything else. Practically, belts should be waterproofed. N. G. NEAR.

Telltale for Steam Traps

AN IMPROVEMENT which has proved most convenient for us is illustrated in the sketch. On our open float steam trap we have mounted expansion air valves as illustrated. In starting, if air is present the valve, being open, allows it to escape. As steam reaches the valve,



TRAP PROVIDED WITH TELLTALE

expansion due to heat closes it. If the trap becomes so full of water it is flooded, the valve will open, due to decreased temperature; the discharge of water then indicates the trouble.

It is customary to equip traps of this type with lever handle air cocks, but how often are they tried to see if the trap is air free or that the trap is able to carry its load? We have found that the above improvement warrants the expense. H. E. WEIGHTMAN.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Oakland, Cal., Examination Questions and Answers

THE FOLLOWING questions, answered herewith, were recently submitted in an examination for position of chief engineer for the City of Oakland, Cal. Morning session; time allowed, 3 hr.:

1. Give method of making test of insulation resistance on a 500-v. motor using a Weston direct-current voltmeter of known resistance.

2. To what extent can a storage-battery cell be discharged without damage to the plates?

3. What is the voltage of a fully charged cell of a storage battery under normal charging current?

4. What effect does charging a storage cell have on the specific gravity of the electrolyte?

5. What should be the minimum specific gravity of the electrolyte in a storage cell?

6. In case the specific gravity of a cell became too high, what should be done to reduce it and how?

7A. What effect has a rise or fall of voltage on a motor connected to a direct-current circuit?

7B. Same as (A), on an alternating-current circuit?

8. What effect has an open coil in an armature on running of motor?

9. What would indicate a grounded or short-circuited coil in an armature?

10. Name some of the causes of an armature coil burning out.

11. What effect would a short-circuited field have on the running of a motor?

12A. How is a voltmeter connected to a circuit?

12B. How is an ammeter connected to a circuit?

13. Give actual circular mils of copper required for a 20-hp., 500-v. motor 300 ft. from the source of supply with 2 per cent drop allowed.

14. Why should all the wires of an alternating-current circuit be in the same conduit?

15A. What do you consider better for elevator purposes, alternating current or direct current?

15B. How would you determine when an elevator cable should be changed?

15C. Name some of the safety devices on elevators.

15D. Describe some methods of elevator control.

16. Name a few of the troubles usually encountered with dynamos and motors, and state treatment required to overcome or prevent them.

17. Describe several methods used for starting, stopping and reversing motors.

ANSWERS

FOR AN insulation resistance test of a field coil, connect the coils, frame, and voltmeter to a 500 v. source of current, as shown in Fig. 1. Note reading of voltmeter. Determine exact value of line voltage, by disconnecting D and B, and connecting positive side of line to left-hand binding post of voltmeter, noting the indicated reading.

Voltage drop along a conductor is directly proportional to the resistance of that conductor, so that if we let the first voltmeter reading be E′ and the second E, and we know the instrument to have a resistance of R ohms, we have, E is to E′ as R is to (R + x), where x is the resistance of the insulation. Solving for (R + x), multiply E′ by R and divide the product by E, or E′R ÷ E = (R + x) or (E′R ÷ E) − R = x.

2. A cell should be considered fully discharged at a voltage of about 1.8 between positive and negative terminals.

3. The voltage of a fully charged cell should be about 2.5 between positive and negative terminals.

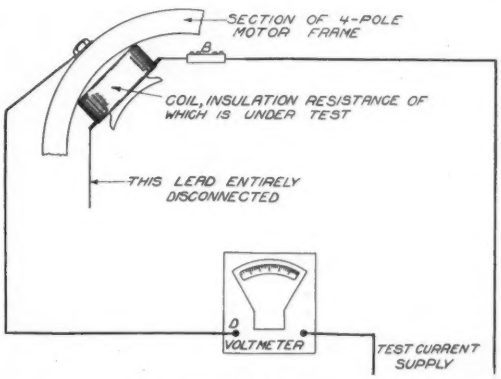


FIG. 1. DIAGRAM OF CONNECTIONS; FIELD COIL INSULATION RESISTANCE TEST

4. On discharge, the electrolyte combines with the active materials of the electrodes and on charge the active materials are reduced to their original condition, the chemicals extracted from the electrolyte being released and returned to the electrolyte, indicated by a higher density of the electrolyte at the end of charge than at the end of discharge.

5. The allowable minimum specific gravity of the electrolyte varies, depending upon the construction of the plates and kind of work performed by the battery. Current American practice indicates values varying from 1.100 to 1.187.

6. Specific gravity of the electrolyte may be reduced either by partially discharging the battery or by diluting the electrolyte with distilled water. The latter should only be done on advice from the battery manufacturers.

7A. The speed of a direct-current motor varies directly as the applied voltage; that is, an increase of voltage will result in an increase of speed and vice versa.

7B. Synchronous motors operate at constant speed regardless of the value of the applied electromotive force, while the speed of induction motors increases with increased applied voltage.

8. Excepting for the detrimental effect on the commutator and brushes, an open armature coil would in no way interfere with the operation of the motor. It is, however, not advisable to run a motor in such condition any longer than absolutely necessary.

9. A grounded armature coil may never be discovered until either a test is made for the purpose or a second ground develops resulting in either an excessive flow of current or a complete short circuit. Short-circuited armature coils are manifested by excessive sparking at the brushes and local heating of armature winding.

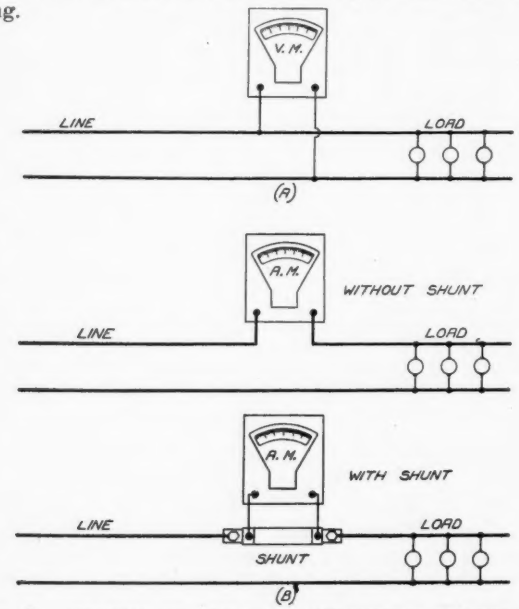


FIG. 2. COMMON METHODS OF CONNECTING VOLTMETERS AND AMMETERS

10. Overload; excessive voltage; poor insulation; careless starting and stopping; damage by lightning; poor electrical connections, either in winding proper or commutator connections.

11. A short-circuited field coil would have a tendency to weaken the field and thereby increase the speed of the armature. Due to such short circuit and consequent decreased field winding resistance, the remaining winding would tend to heat and either damage the insulation or burn out entirely.

12. See Fig. 2; A is voltmeter connection, B is ammeter connection.

13. We will assume that this motor is required to deliver 20 hp., and that its efficiency is 90 per cent.

With a voltage of 500, the current flow at full load will equal the product of 20 times 746 times 100, divided by the product of 500 times 90, or 33.15 amp.

It is advisable to consider a possible overload of, let us say, 25 per cent, resulting in a line current of 1.25 times 33.15, or 41.43 amp.

The resistance of an electrical conductor is equal to the product of a constant, K, which for copper is 10.8, times the length of the conductor in feet, divided by the area of the conductor in circular mils. Transposing this, we find the area equal to the product of, the constant K times length of conductor, divided by resistance.

From Ohm's law, we know that the resistance is equal to the electromotive force divided by the current, so that by substituting this value of resistance in the formula given for the area of the conductor, we have the area in circular mils equal to the product of the current, in amperes, times constant K times the length of the conductor in feet, divided by the voltage.

In this problem, we have the current equal to 41.43 amp., K equal to 10.8 and the length of the conductor 2 times 300 ft., or 600 ft. A 2 per cent voltage drop is 0.02 times 500, or 10 volts.

Substituting these values in the above formula for the required area, we have the product of 41.43 times 10.8 times 600, divided by 10, or 26,846 circular mils, equivalent to approximately a No. 6 B. & S. wire.

14. Unless all lines of an alternating-current circuit are placed in one conduit, a choking action will take place, reducing the flow of the current and causing the conduit and lines to become excessively hot.

15A. Alternating-current motors, especially those of the polyphase slip ring induction type, are preferable.

15B. Ordinarily elevator cables are considered unsafe and should be condemned when through broken wires, wear, rust, undue strain, etc., the strength of the cable has deteriorated 25 per cent.

15C. Automatic terminal stopping device; slack cable switch; final hatchway limit switches; governor switches; car safety switch; car safety devices.

15D. The most common methods of elevator control are the car switch-magnet control, automatic push button control and hand rope control.

The first mentioned method is suitable for all car speeds and consists of a master switch located within the car, electrically connected to the operating coils of the magnetically actuated switches on the control panel. Connections are so arranged that after direction has been established, the proper sequence of switches is obtained for the desired acceleration and retardation. The car switch is usually so designed that it will automatically return to stop position should the operator's hand for any cause be removed.

By means of a special type of magnet controller, elevators can be operated by a selective arrangement consisting of a call button located on each floor and a series of buttons corresponding to the floors to be served located within the car.

In the hand-rope-control method, the contacts of the reversing switches are operated by the revolving of a small sheave, to which they are directly or indirectly attached, the revolving of the sheave being accomplished by a pull on an endless rope connected thereto and installed in the hatchway in order to be available from the car. This method of control becomes difficult to handle as the speed of the car is increased and for this reason is limited to car speeds below 150 ft. per min.

16. Sparking of commutator and brushes; heating of windings; heating of bearings; failure of generator to build up; failure of motor to start.

Sparking at commutator and brushes may be due to overload on machinery or dirty or worn condition of brushes and may be prevented by reducing load or turning down and sanding commutator and refitting brushes. It may also be caused by internal armature trouble, such as a short-circuited, grounded or open armature coil. Projecting mica, causing the brushes to ride above the commutator segments, will also result in sparking and may be avoided by under-cutting the mica. When the brushes are not in the neutral position, sparking will result, but can be avoided by shifting the brush holder until the neutral position is reached.

Heating of windings may be brought about by excessive overloads, poor ventilation; short-circuited sections of the windings and may be prevented by reducing or removing the overload, and eliminating the short circuit. Poor ventilation is a question of design.

Heating of bearings may be due to improper alinement, belt too tight, or use of dirty or cheap grade of oil. May be reduced by lining up the bearings, reducing the belt tension or renewing the oil, depending upon the cause of the trouble.

A generator may fail to build up due to loss of residual magnetism, or open armature or field connections. If cause of trouble is the first mentioned, residual magnetism may be re-established by passing a weak current through field windings in proper direction. Generators have been found to fail to build up, due to attendant having raised or removed brushes for cleaning or other reason and failed to replace them before starting up.

The usual cause of failure of a motor to start up is improper or open armature, field or line connections.

17. Various methods of starting motors are employed, depending upon the type of motor and the service to which it is to be put, and range from the connecting of the machine directly across the line in small types of direct and alternating current motors, to the more elaborate systems of remote control.

The most common method of starting direct-current motors employed in stationary service, consists of an ordinary 2-pole single-throw knife switch and starting box so connected that when the handle of the starting box is thrown onto the first contact, the shunt field is connected directly across the line, as is also the armature, although only through the resistance of the starting box. As the armature picks up speed, the handle of the starting box is gradually brought to the last point at which all of the resistance is cut out of the armature circuit and the armature then working at full line voltage. In some instances, these starting boxes are so arranged that as the resistance is being cut out of the armature circuit, it is at the same time being cut into the shunt field circuit, tending to weaken the shunt field so as to aid in the acceleration of the armature.

Alternating-current induction motors, excepting those of the smaller sizes, are generally started through the medium of some form of auto transformer. Synchronous motors, while usually employing some outside source of power to bring them up to speed before being thrown onto the line, may, by means of induction motor action, be started by some form of starting device similar to that employed with the regular induction motor.

(To be continued.) O. H. H.

Alternating Current for Ignition

THE QUESTION has recently come up whether alternating current could be used to replace batteries in the ignition circuit of small gas engines. I was doubtful of its success on an alternating current circuit, although I have seen one small 35-hp. engine working, using an ordinary alternating current lighting circuit and lamps, but not with any degree of success.

If you know of any direct current arrangement without the use of batteries floating on the line, I would be interested to hear of it. F. G. F.

A. Whether alternating current could be used for ignition on a gas engine would depend on the style of the ignition. If it were a make and break ignition, such as is used in many styles of stationary engines, such current can be used, provided the voltage is high enough.

The usual difficulty in such cases is that the voltage of the circuit is not sufficiently high to give a satisfactory spark.

In the jump-spark system, alternating current could not be used, since this depends on the use of a vibrator or step-up of some kind, and the vibrator depends for its action on the characteristics of a direct current.

The fact that the direct current has been almost universally adopted by the engine builders for ignition purposes, would indicate that alternating current has not been found available, because the alternating-current magneto would be much simpler to build and operate than the direct-current.

For a direct-current arrangement, there are, of course, the high-tension magnetos, which are found entirely satisfactory. There are any number of these on the market, whose names have been made familiar by the automobile trade. The Bosch, manufactured by the Bosch Magneto Co., 160 W. 56th St., New York City, is probably the most widely used.

The Apple Electric Co., Dayton, Ohio, also specializes in this line. K. W. Ignition Co., Cleveland, O., Kingston Electric Co., Kokomo, Ind., and Sumter Electric Co., Sumter, S. C., have good devices. A. L. R.

Locating Leaky Tubes

A HEINE water-tube boiler has a tendency toward leaky tubes, due to splits and small holes occurring about 1 ft. from the ends of the tubes.

Pending the time when we can retube the boiler, what methods can we use to find which tube or tubes leak, when the water comes from somewhere in the middle of the nest. H. K. S.

A. The best way we know of to locate a leaky tube in the upper rows of our boiler is as follows:

Get in on top of the tubes with a lighted candle held by a wire 3 or 4 ft. long, pass the candle down diagonally between the tubes, and the leaky tube can easily be found by following the wet surface. The boiler should, of course, be filled with cold water under pressure at the time, and observations will have to be made between the several rows of tubes and in the 2 directions in order to examine the entire nest of tubes.

This way is simple and may seem crude, but we know of no better or refined method.

HEINE SAFETY BOILER CO., J. H. HINMAN.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Peculiar Boiler Performance

I AM in charge of 3 Badenhausen water-tube boilers, one of which, known as No. 1, is rated at 400 hp., while the other 2, known as Nos. 2 and 3, are rated at 460 hp. each.

One Sunday afternoon while boilers 1 and 2 were under a pressure of 100 lb. gage and carrying water at about the second gage, the water, from some unknown cause, suddenly rose, appearing to fill the boilers completely and remaining in that condition for nearly an hour. Boiler No. 3 was at this time cut out for inspection and all valves on that and the other boilers closed tight.

This peculiar action has been a puzzle to everyone to whose attention it has been brought, and, as I have been unable to gain a satisfactory explanation, I would appreciate an opinion from the readers of Practical Engineer.

A SUBSCRIBER.

Caring for Idle Boilers

WE HAVE a Scotch boiler which is used on Sundays only while the others are being cleaned; the rest of the week this boiler is idle. How shall I leave this boiler during the remaining 6 days? Should it be drained of all water or should I leave the water in? Would the latter method cause any damage?

I have had considerable trouble with the dry pan of a Stirling water-tube boiler. This pan consists of a drum provided with 96 perforations which become so plugged up with dirt that I am compelled to clean them quite frequently. I wish, therefore, that some of the readers of Practical Engineer would tell me whether or not it would be good policy to redrill these holes, making them ½ instead of ¼ in. as they now are. Would larger size holes tend to allow water to enter the main header when the boilers foam as they do, especially during the summer months?

M. W.

Boiler Settings for Lignite

IN OUR PLANT are 4 72-in. by 16-ft. fire-tube boilers in the furnaces of which we use lignite having an average heat value of 6000 B.t.u.

When I came here about 3 yr. ago the boilers had grates 6 ft. wide and 4 ft. deep, with herringbone bars having ribs and air spaces each ½ in. wide, which I replaced with bars of the same style but with ⅜-in. ribs and ¼-in. air spaces and at the same time increased the depth to 6 ft. The grate bars were originally set level at a distance of 22 in. from the boiler shell, which I also changed, giving all of the bars a drop at the rear of 4 in.; this I afterwards increased on 2 of the boilers to 10 in. I further cut down the bridge wall leaving just enough of them standing to prevent the fuel from going over into the combustion chamber. I will state that although I was advised by some of the old timers not to make the changes I did make, I have since found as a result a decided improvement both in steaming capacity and in fuel economy.

The settings of these boilers are quite old, so I want to rebuild them, and while I feel sure that raising them more than 22 in. above the grates as they now are will still further improve the economy of the units, I am not certain just how much I should make this. I would therefore greatly appreciate the opinion of some of the readers of Practical Engineer on this subject.

Has the U. S. Government at any time made any experiments along this line?

W. G. M.

Economy of Oil Burning

I HAVE CHARGE of a 100-hp. boiler which, excepting on one day of each week when it is worked at full rated capacity, is wasting about 50 or 60 per cent of the fuel we fire, due to being operated the rest of the time with exceedingly light and intermittent loads. We burn approximately 3200 lb. of coal a day, costing $4.35 a ton and, according to my estimation, we could reduce our coal bill at least $100 a month by the use of oil fuel. I suggested the use of this fuel to my employer, but he refuses to see any gain to be accomplished, citing several southern plants forced to drop it due to the advance in price of oil. Still, I feel that in our case he could save money by cutting down the supply to meet the demand.

If any of the readers can tell me of the necessary changes required and quote prices either for oil burning or producer gas equipment, I would appreciate hearing from them.

C. G. M.

Dry Kiln Trouble

I WISH to answer J. S. S. in regard to his dry kiln trouble as stated on p. 930 of the Oct. 1 issue. It has been my experience in dry kiln work, that a square foot of radiation will condense from ¼ to ½ lb. of steam per hour, depending a great deal upon the material the building is made of and the circulations in the kiln. As a boiler horsepower is defined as 34½ lb. of water evaporated per hour from a feed water temperature of 212 deg. F. into steam at the same temperature, it is readily seen that if J. S. S.'s dry kiln would work under the most favorable conditions—that is, at ¼ lb. of steam per square foot of radiation—one boiler horsepower would supply 138 sq. ft. of radiation. I would advise

J. S. S. to give the size of his kiln and the number of square feet of radiation, or, if he is not able to do this, let him state how many running feet of pipe, and the size, and we will be able to tell him if his 10-hp. boiler is large enough or not. The way his question is stated, it is impossible for anyone to give him a correct answer. JAS. BROWER.

A Big Grate at Light Load

IN ANSWER to the inquiry of G. M. C., page 976, Oct. 15 issue, I would state that I have seen conditions similar to those he mentions. I would advise him to extend the bridge wall toward the front on the top of the grates a distance of, say, 4 in. at the start. Then if he gets sufficient steam at full load, add a trifle more. He may also try regulating the damper, varying the draft with the demand for steam; or place one row of fire bricks on each side of the furnace on top of the grates, pulling them out as the heavy load comes on.
CHAS. MAGNUS.

Grate Surface at Light Load; Distilled Water on Shipboard

REPLYING TO G. M. C. and J. C. L., page 976 of the Oct. 15 issue of Practical Engineer, I offer the following:

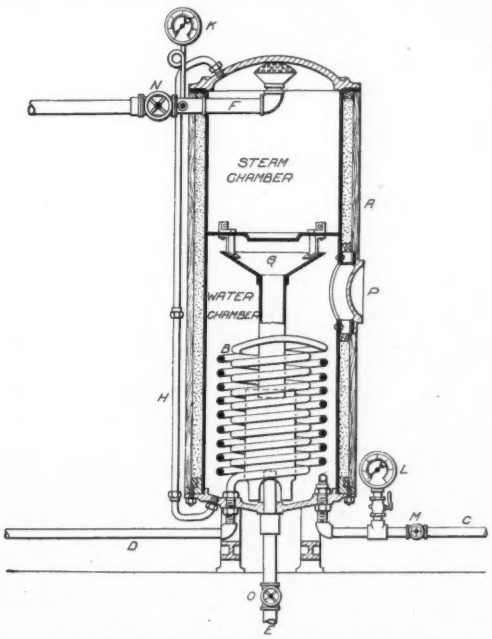
Under the conditions which exist at the plant referred to by G. M. C., it would be advisable to reduce the grate surface to suit the light load period, and install a suitable blower for the heavy load periods. The grate surface may be reduced by extending the bridge wall forward, toward the furnace door. Just how much reduction should be made can be found only by experiment and by using good judgment. From the figures given by G. M. C., it would seem that ½ of the present grate area could be dispensed with, but it would be well to start out with a 25 per cent reduction, and note results.

By installing the blower the heavy loads may easily be carried with the reduced grate area. A saving will be effected that will be permanent, and it will not take long to pay for the installation of the blower. If G. M. C. decides to act upon the foregoing suggestions, it would be interesting to hear from him again, as to how he succeeds, and just what he does.

In answer to J. C. L., I would say that in many ships, fresh water is carried in tanks that are installed for that purpose, but evaporators are also used. It is possible that in some small ships no fresh water tanks of considerable size are carried, and so all fresh water is obtained by the use of evaporators. The number and size of the evaporators are determined by the quantity of water required daily. The accompanying illustration shows one such evaporator used on shipboard, and the following describes it:

The shell A contains a pipe coil B. Both ends of this coil pass through the lower head of the cylinder. To one end of the coil is attached a steam pipe C, taking steam from the receiver of the main engines, and in some cases from the boiler direct. There is a steam gage L and a stop valve M attached. The other end of the coil is connected to a drain pipe, D, leading to the hot well, or to a tank for that purpose, and from which the water of condensation may be drawn for feed to the boilers again. A feed pipe, E, fitted with a stop valve, O, is screwed through the lower head as shown. This connects either with the sea, or with the sea side of the condenser. The pipe, F, with a stop valve, N, and a combined vacuum and pressure gage, K, is connected to the steam side of the condenser. Above the coil of pipe, B, is fitted a separator, marked G. The separator prevents the sea water from entering the pipe, F, when the ship is rolling as in a seaway. There is a manhole in the shell; this is marked P.

The evaporator is operated like this: When valve N is opened, a vacuum will be formed in the evaporator, due to its connection to the condenser. Valve O is next opened, admitting the sea water. The glass gage, H, shows the height of water at any time. The coil, B, should be covered with water to a depth of at least 3 in. Steam is then admitted to coil B, which in time evaporates the sea water surrounding it. The steam from the sea water flows through the separator, G, into the pipe, F, and then into the condenser, where it becomes fresh water. The rate of evaporation is regulated



BAIRD EVAPORATOR USED ON SHIPBOARD

by the valve, M, in the steam pipe, C, the gage showing just what is the pressure. The higher the pressure, the higher the temperature, and the faster will the water be evaporated, and the greater the quantity in a given time.

More water is continually added by opening the valve O.

The density of the water in the evaporator will increase during operation, and so some of it must be blown off occasionally, and new water added to make up for that blown out. To blow off, the stop valve, N, must be closed, this causes some of the sea water to be evaporated, and a rise in pressure, as will be indicated by gage K. Then valve O is opened when a sufficient steam pressure has been reached, and the water will be blown out, and a new charge refilled ready for evaporation. CHARLES J. MASON.

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Fall Trouble

Now the annual burden has been added to the duties of the great majority of power houses throughout the country and this periodic demand for steam has already caused trouble in some plants and more trouble may be confidently expected and looked for as the demand for heat increases.

Many plants have operated efficiently and satisfactorily during the warmer months on condensing service, in which the condenser is now replaced by a system of heating mains that performs the functions of condensing—partially condensing, in any event—the steam discharged by the power units and, at the same time, heating the buildings. This double operation cannot be realized without a certain loss of the available energy or power developed under the more favorable operating conditions of the summer months, which loss is measured by an increase in the back pressure on the engine. Notwithstanding this unavoidable power loss, exhaust steam heating is unquestionably the most economical method of heating many mills and factories.

At the same time, economy demands that the exhaust heat from the heating system be conserved and utilized as far as possible. This may be accomplished by returning the drips and partially condensed steam to the boiler, via the feed water heater, the feed pumps, etc., and herein frequently lies the cause of much trouble. The heating mains having remained idle all summer have had an excellent opportunity to rust, collect sediment and have possibly become more or less thoroughly lined with scale, adhering with varying tenacity to the inner surfaces of piping. On starting up the heating system, this collection of refuse is carried to the auxiliaries and thence to the boiler itself, causing trouble and damage to all equipment. If new steam pipes have been added, or corroded sections of the old piping replaced by new, the chance of serious trouble is frequently aggravated, for it is not an uncommon condition to find the new pipes clogged with chips from threading, iron splinters, white lead, grease and dirt of all kinds. Not only do such foreign materials greatly reduce the efficiency of the heating system, but they nearly invariably bring serious trouble.

The remedy and the precaution to guard against trouble on starting up the heating system are the same. The heating system should be thoroughly blown out with live steam at the highest available pressure. This necessitates the deliberate waste of a few pounds of steam, it is true, but is much preferable to and less expensive than the gradual reduction in boiler efficiency and the probable serious damage to equipment that results from failure to take such precautionary measures. Furthermore, the blowing out of the heating mains with high pressure live steam should be performed several times during the heating season, for some of the scale and sediment may not be easily loosened and fail to be carried off by the first or second "blow." The operation of the heating system may in itself soften up the scale or sediment, so that, even should little trouble be encountered during the first of the heating period, subsequent operation, particularly when the demand for steam grows greater, may result in considerable damage. It is impossible to foretell exactly when the scale and

sediment will move, so a periodic "blow" is advisable.

The plants that have been careless in the manner of starting up their heating systems may still forestall trouble by adopting the practice of periodic "blows" and the plants that have already taken the precaution of blowing out their heating mains should not rest content with such foresight, but continue to forestall trouble by a continuation of the preventive measures.

News Notes

MEETING OF the Ohio Society of Mechanical, Electrical and Steam Engineers will be held at Zanesville, O., Nov. 18 and 19, the business to be transacted being election of officers, reading and discussion of papers, and visits to plants. Headquarters will be at the Clarendon Hotel, and a large attendance is anticipated. Election of officers will be on Friday afternoon. Visits to industrial buildings will include the American Tiling Co., Mosaic Tiling Co., Griffith & Wedge Co., Ferguson Electric Co., Zanesville Electric Light Co. and others.

Papers to be presented are, "The Burning of Powdered Coal," by Joseph Harrington; "Smokeless Furnace Design," by Osborn Monnett; "Soot, Its Composition, Effect and Removal," by F. A. Moreland; "Advertising, and Its Influence on Engineering," by A. R. Maujer; "Steam Traps," by A. A. Crier; "Monel Metal in Engineering," by C. H. Biddle, Jr. This list of interesting papers ensures a profitable time, and the large attendance of men, all interested in kindred lines, is guarantee of an enjoyable time.

THE COLORADO STATE SCHOOL OF MINES announces that the board of trustees have elected James Cole Roberts, of the United States Bureau of Mines, Denver, to the Joseph Austin Holmes professorship of safety and efficiency engineering. Mr. Roberts assumed his duties Nov. 1.

THE SPRAGUE ELECTRIC WORKS of General Electric Co. has recently opened a sales office in the Provident Bank Building, Cincinnati, Ohio, under the management of Frank H. Hill. The Cincinnati office has been established to facilitate the prompt and efficient handling of the increasing business in that section.

W. E. HARDY, for the past 11 yr. connected with the Diamond Rubber Co. and the B. F. Goodrich Co. and lately in charge of the sales of their Mechanical Rubber Goods Division, has lately been appointed sales manager of the Boston Belting Co., Boston, Mass.

A NEW PUBLICATION has just been issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce, which should be of a high degree of interest to all who are giving attention to the problem of the extension of our trade abroad. It is entitled "Financial Developments in South American Countries," and reviews in about 40 pages of a very clear and forcible style the situation as regards the currency, the money market, the principal banks, and the general condition of business in Argentina, Bolivia, Brazil, Chile, Peru, and Uruguay, during the last 2 or 3 yr. Especial emphasis is placed on the results of the European war and the measures taken by the various governments, financial institutions, and commercial communities to meet the situation thus created.

The author of this publication is William H. Lough, vice-president of the Alexander Hamilton Institute, who has recently made a trip through the countries treated. Bankers, manufacturers and exporters who wish to obtain definite and up-to-date information with regard to the present state of affairs in South America as to credit extension, government finances, currency conversion, emergency measures and prospective changes and reforms should by all means acquaint themselves with the contents of this book. It is to be had from the Superintendent of Documents, Government Printing Office, Washington, D. C., for the price of 5 cents.

THE INFLUENCE of Temperature Upon the Strength of Concrete, by A. B. McDaniel, has been issued as Bulletin No. 81 of the Engineering Experiment Station of the University of Illinois. This bulletin presents a study of the data obtained from 3 series of tests of concrete cubes and cylinders. The data are presented in the form of curves, which show the relation between strength and temperature at different ages. This bulletin will be of value to the contractor, engineer and others engaged or interested in construction work for information regarding the strength which may be expected of ordinary concrete under different age and temperature conditions, and the time of the removal of the forms.

Savings Fund for Westinghouse Employes

IN ORDER to encourage the spirit of thrift among its employes, the Westinghouse Electric & Mfg. Co. has just established a savings fund which offers facilities to the employes for the handling of their savings accounts. This fund is open to any employe of the company wherever he may be located, and he may become a depositor at any time and discontinue at any time. The amount of the deposit cannot be less than 10c. and may be any multiple thereof, and the deposits must be made from each regular pay. The deposit, however, is limited to one account, the amount of which in any one year cannot exceed $500. The idea of this is that the plan is intended as a method of encouraging the employe to save his earnings and when he has been successful up to this point, allow him to handle his own finances.

Interest is paid on the deposit at the rate of 4½ per cent and is credited semi-annually.

An interesting feature of the fund is that the Westinghouse Electric & Mfg. Co. acts as a trustee and guarantees the deposits and interest.

The rules provide that an amount of $100 or less may be withdrawn without notice, but an interval of 2 weeks must elapse before subsequent withdrawals can be made, and for withdrawals more than $100, notice of one week must be given.

An auditing committee not to exceed 7 persons is to be elected by the depositors from among their own numbers, which committee shall be given an opportunity to examine the condition of accounts at semi-annual interest period, the findings of which shall be published.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

New Oster Die-Stock for Pipe

AFTER years of experience and trial, the fundamental idea of the Oster 2-in. Matchless Ratchet Stock has been applied and improved to develop a new stock of larger capacity. The mechanics of construction are interesting, for they accomplish results which produce good work and save money. Here is the action step by step.

The leader screw is in position to thread, when the slant-post which recedes the dies, is flush with the face of the die stock. (See cut.) The tool, which weighs only 77 lb., is placed on the pipe. Then with a small rod or scrap of pipe, revolve the universal scroll chuck until the gripping jaws are solid on the pipe. The chuck is strong enough to crush the pipe, and there is no chance for a slip in the grip. Now with one handle

OSTER MATCHLESS NO. 4BR RATCHET STOCK AND DIES

or two, whichever is more convenient, the stock can be turned to cut the thread. There is a little trick here that will not be found anywhere else in the die-stock field.

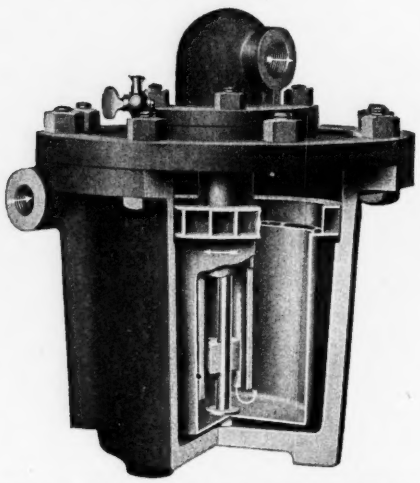
Doubtless it has often been found difficult to turn the ratchet die stock on the thread because it would slip back the full length of the stroke, and force the operator to hold it with one hand, until another tooth was caught in the ratchet with the other. This annoying backward movement is called "black-lash." Number 4BR Matchless Ratchet has no back-lash. This has been done away with in a little pawl, which holds it up to place, so after setting it once, one need only pull on the handle until the thread is done, and it gets easier as the thread gets longer. When the end of the thread is reached, the "slant-post" has carried its spring-head above the face of the stock and the cam is free. Then by moving it to the left, the dies are free from the thread. When backing out, press the "back-lash trigger," and reverse the ratchet pawl, so it will work equally well backward or forward. This stock does not cut as easily as the geared stocks, but it works easily enough, is inexpensive, and a good time saver.

Accurate tests of this new type, to show the actual pounds of pressure to cut each size of pipe, show that to cut a clean, deep and perfect thread on 4-in. pipe, the pull was easy enough for any ordinary man. Over half time is saved over the same thread with geared die stocks. This tool is manufactured by The Oster Manufacturing Co., Cleveland, Ohio, in pipe sizes ranging from 2½ to 4 in.

Revolving Bucket Steam Trap

REVOLVING of the bucket in the R-P steam trap automatically cleans and burnishes the valve seat at each discharge, thereby preventing wire-drawing and leakage. This is accomplished by a rotating motion as the valve reaches its seat at the end of each discharge.

At the top of the bucket are provided pockets, as shown in cut, so that the steam when entering on a



THE R-P STEAM TRAP FOR HIGH PRESSURE

tangent causes the bucket, stem and valve, to rotate, thereby regrinding the valve and seat surfaces.

Taking the water of condensation in at the bottom of the trap body on a tangent keeps the mud and sediment in a flocculent condition so that they are readily blown out through the discharge line.

The R-P trap—the Robertson Principle—is manufactured by the John F. Robertson Co., 620 Park Building, Pittsburgh, Pa.

The Hovalco Valve

ONE OF the most notable changes in the steam boiler fitting line is the growing use of the twin or double blowoff valve arrangement, by which 2 valves are used on each blowoff line. These valves are usually of different types, such as a plug cock and an angle type valve or a gate valve and an angle valve.

This arrangement also gives double assurance against leakage, and for this reason is economical, as a small

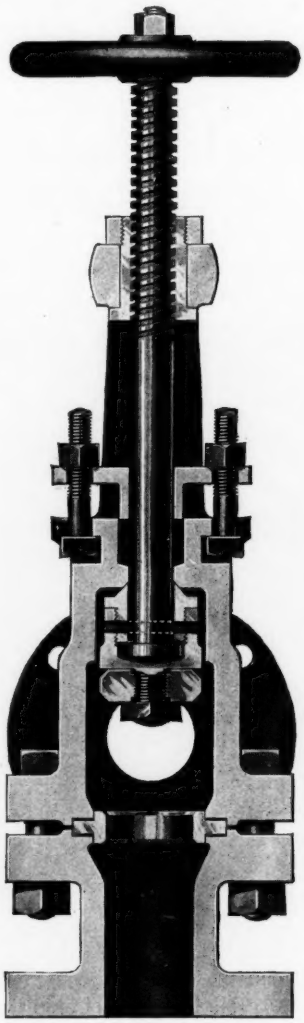


FIG. 1. SECTIONAL VIEW SHOWING CONSTRUCTION OF HOVALCO VALVE

leak soon amounts to the additional price of the extra valve. Another advantage of this arrangement is that the valve nearest the boiler can be closed while the second valve is being repaired, without closing down the boiler.

The "Homestead Valve," a valve of the plug cock design, has long been recognized as a suitable valve as one of such a combination. In order that they may be able to supply the demand for both valves on the double blowoff arrangement which has developed among the leading and most up-to-date installations, the Homestead Valve Manufacturing Co., makers of the Homestead Quarter Turn Valve, has designed an angle type blowoff valve, "The Hovalco," suitable for use in connection with the Homestead Valve as shown in Fig. 2.

The construction of the Hovalco Blowoff Valve is shown in Fig. 1. The valve body is made of semi-steel, the seat and disc of "Monel" metal. The seat can be reground, reversed or renewed with greatest ease, all that is necessary being to loosen the 4 bolts holding the valve body together, the seat being released at the same time. The disc can also be easily removed.

FIG. 2. THE HOVALCO VALVE USED IN CONNECTION WITH THE HOMESTEAD VALVE

The Homestead Valve used alone as a boiler blowoff in numerous cases has given satisfactory service for 12 to 14 yr. without repairs. The Hovalco Valve used in connection with the Homestead Valve will solve the blowoff question on any boiler and, as said by the manufacturers, will, with ordinary care, outwear the boiler in length of service.

Lea V-Notch Meter at Exposition

ONE OF the interesting exhibits in the Palace of Machinery, at the Panama-Pacific Exposition, is that of Yarnall-Waring Co., Philadelphia.

At the front of the exhibition space is a full-sized working "Lea" V-notch recording liquid meter. Recording instrument, float and V-notch are all complete, as is also the tank with the exception of the top, which has been removed. Ingenious arrangements have been made, so that the actual operation of the meter may be followed through from start to finish.

A centrifugal pump operates the apparatus. It lifts the water to the chamber in front of the V-notch weir, over which it must pass to be metered. An electric light has been placed under the flow of water over the V. Another light has been placed in the instrument case above the tank, where the recording pen traces the amount of flow over the weir on a chart.

An observer may stand in front of the case, and by operating a valve controlling the amount of flow over the weir, watch the action of the recording instrument, just as though it were under actual working conditions.

Simplex seatless blowoff valves are also shown to excellent advantage. A quarter section has been cut from one valve, permitting a close inspection of the no-seat-to-leak construction. Operation of the hand wheel causes a plunger to rise or fall. This plunger fits so perfectly into the valve body that very little packing is required, and what little is used is placed in the sleeve or follower gland, where it is at all times protected from the destructive blast of the blowoff, whether the valve is wide open, closed or only partly closed. In actual practice this packing lasts for years, without any need for renewal.

A remedy for pipe joint leaks is exhibited in the form of Simplex pipe-joint clamps. These consist of 3 parts, an outside ring, inside square ring, and packing ring. Simplex clamps are well known to engineers, and are in universal use throughout the country.

W. J. Marland has charge of the exhibit. He has succeeded, in connection with the company's San Francisco agents, the H. F. Lyon Co., in making the exhibit not only interesting, but actually instructive as well.

The Burt Ball Bearing Revolving Ventilator

IN ORDER to meet the great demand for an up-to-date revolving ventilator, the Burt Mfg. Co., of Akron, O., has designed and is now placing on the market a ventilator of this type.

This ventilator, made from heavy-gage open-hearth galvanized iron, is fitted throughout with high grade ball bearings, eliminating all possibility of sticking or binding. Its distinctive construction, which may be noted by referring to the 2 accompanying illustrations, causes the exterior air current to pass not only across the top and sides of the ventilator, but directly through, thus creating a partial vacuum, which greatly increases its drawing power. This construction also has a tendency to hold the ventilator steady with the wind, preventing the continuous revolving action found in some ventilators of this type.

If so specified, these ventilators can be furnished with a fire retarding damper, which will automatically close in case of fire.

The manufacturers of this ventilator will gladly send literature to those interested, and their engineering department is prepared to co-operate with architects, contractors and consumers in selecting the proper type and size of ventilator to suit any particular conditions and requirements.

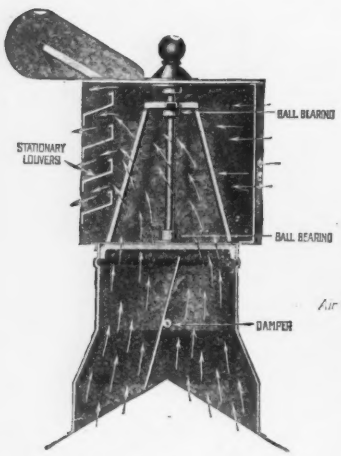


FIG. 1. SECTION THROUGH BURT BALL BEARING REVOLVING VENTILATOR SHOWING PATH OF AIR CURRENTS

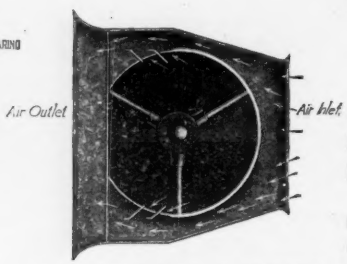
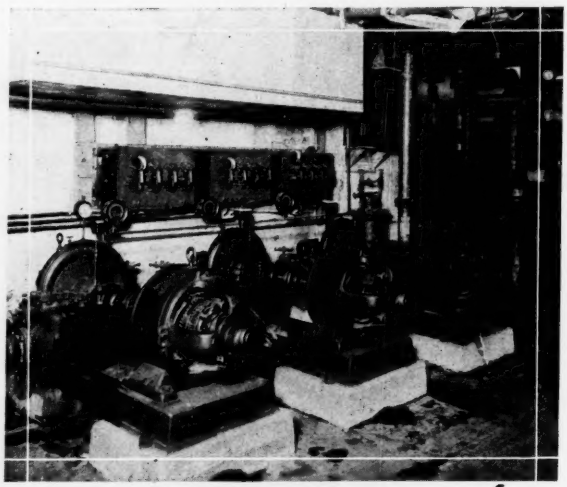


FIG. 2. HORIZONTAL SECTION THROUGH BURT VENTILATOR SHOWING AIR CURRENTS PASSING THROUGH BODY OF VENTILATOR

Interesting Installation of Centrifugal Pumps

IN the Hotel Baltimore, Kansas City, Mo., water is distributed from a large pressure tank located on the roof of their 12-story building. This tank is normally kept charged by city pressure which is about 80 to 85 lb. at the basement. As this pressure drops at times these "booster" pumps are required in order to keep the tank filled.



GOULDS CENTRIFUGAL PUMPS USED AS BOOSTERS

Two of these pumps are in parallel, each with a Cutler-Hammer pressure controlled self-starter to cut in one of them when the pressure drops below a certain point. One of these is kept in reserve all the time.

The discharge of the third pump is connected to the suction openings of the first two and has a pressure control which will cut it in if the city pressure should fail entirely, as it sometimes does. In that case this pump and one of the first two will be working in series.

The pumps are Goulds Fig. 3001 No. 4L Double Suction Centrifugals direct-connected to 25-hp., 1400-r.p.m. type S K Westinghouse motors. Pumps have a capacity of 300 g.p.m. each.

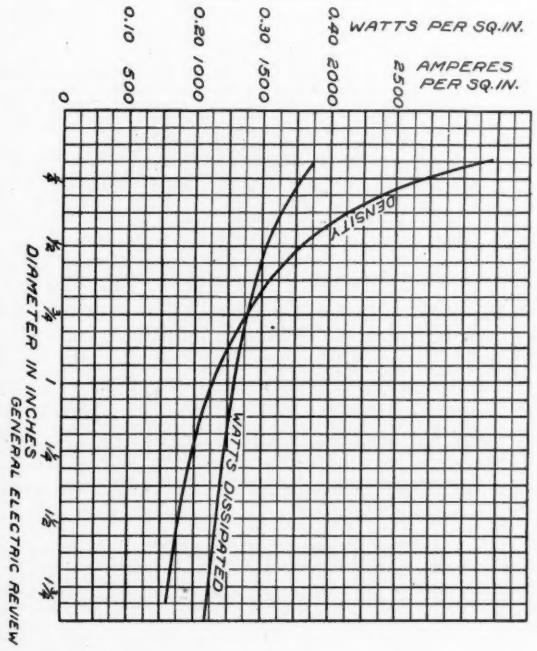
A SAFE RULE for proportioning boiler capacity to engine capacity is to provide 15 sq. ft. of boiler heating surface to each rated horsepower of the engine.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

—The Electric Journal.

PRACTICAL ENGINEER

WATT DISSIPATION AND CORRESPONDING CURRENT DENSITY AT 30 DEG. C. RISE FOR CYLINDRICAL COPPER BUSBAR CONDUCTORS



PRACTICAL ENGINEER

TEST VOLTAGE FOR INSULATION TESTS

DIRECT-CURRENT MACHINES AND ROTARY CONVERTERS

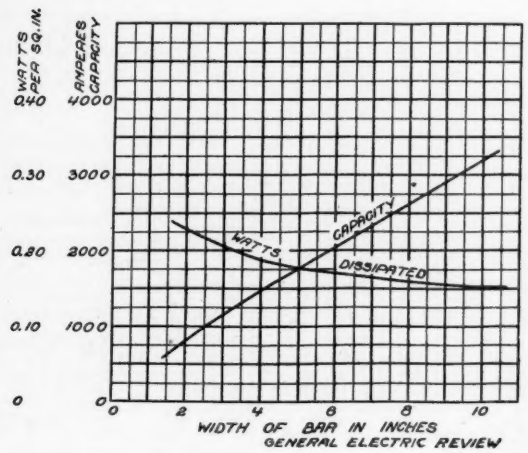
	Assembled Field	Assembled Armature		Assembled Motor		
	Field Coils to Ground	Comm. to Ground		Complete Armature Insulation	Before Coils or Commutator are Placed on Rotor	
Rated Terminal Voltage	Momentarily	Momentarily	Momentarily	One Minute	Between Adjacent Turns in Coil	Between Adj. Commutator Bars
400 and less	1250 volts	2000 volts	4000 volts	1500 volts	100 volts	400 volts
401-600	2500 volts			2000 volts		

ALTERNATING-CURRENT MACHINES

	Before Coils are Placed in Machine		After Coils are Placed in Machine			Complete Machine			
		Between Conductors in Coil	Conductor and Coil Insulation	Armature Coil and Ground	Between Phases	Complete Machine to Ground	Field Coil to Ground	Complete Field to Ground	
Rated Terminal Voltage		Momentarily	One Minute	Momentarily	Momentarily	One Minute	Momentarily	One Minute	
600 and less	2500 volts	800 volts	1500 volts	1000 volts	1750 volts	1500 volts	3000 volts	1500 volts	
1100	2500 volts	800 volts	1500 volts	1000 volts	1750 volts	1500 volts	3000 volts	1500 volts	
1200	2500 volts	800 volts	1500 volts	1000 volts	1750 volts	1500 volts	3000 volts	1500 volts	

PRACTICAL ENGINEER

D.C. AMPERE CAPACITY AND WATT DISSIPATION AT 30 DEG. C. RISE FOR SINGLE COPPER BUSBARS OF VARYING WIDTHS, 1/4 IN. THICK



PRACTICAL ENGINEER

VALVE SIZES AND GAS VELOCITIES OF SLOW SPEED GAS ENGINES

NO.	RATED HP.	BORE	STROKE	PISTON SPEED	VEL. OF CHARGE	DIA. OF INLET VALVE	DIA. EXH. VALVE	$a = \frac{AS}{6000}$	$a = \frac{AS}{5100}$
1	5 1/2	6	6 3/4	421	2719	2 3/8	2 3/8	1 7/16	1 3/4
2	6	5	6	400	3266	1 7/8	1 7/8	1 5/16	1 7/16
3	8	5 3/4	6 3/4	421	2500	2 3/8	2 3/8	1 1/2	1 11/16
4	12	6 1/2	7 1/2	406	2172	2 13/16	2 13/16	1 11/16	1 7/8
5	15	7 1/4	8 1/4	412	2980	2 13/16	2 13/16	1 7/8	2 1/16
6	20	8 3/4	10 1/4	427	.2500	3 5/8	3 5/8	2 5/16	2 9/16
7	3 1/2	3 1/2	4 3/4	400	4800	1 3/8	---	1 5/16	1 3/8
8	5	5	5 1/2	400	4600	1 5/8	---	1 5/16	1 7/16
9	7	6	8	466	4960	1 7/8	---	1 11/16	1 13/16
10	10	7 1/4	8	466	6125	2	---	2	2 3/16
11	12	7 1/2	8	466	6533	2	---	2 1/8	2 5/16
12	3	5	6	400	1933	2 1/4	2 1/4	1 5/16	1 7/16
13	5	6	7	420	3194	2 1/4	2 1/4	1 9/16	1 3/4
14	7	6 3/4	8	400	- - -	2 3/4	2 3/4	1 3/4	1 7/8
15	10	7 1/2	10	375	4086	2 3/4	2 3/4	1 7/8	2 1/16
16	13	8 1/2	12	500	-----	3 1/2	3 1/2	2 7/16	2 5/8
17	16	9 1/2	12	500	-----	3 1/2	3 1/2	2 3/4	3
18	8	6 1/2	10	500	3385	2 1/2	2 1/2	1 7/8	2
19	46	10 1/2	15	687	5390	3 1/4	3 1/4	3 5/16	3 7/8
20	35	10 1/2	11	550	4950	3 1/2	3	3 3/16	3 1/2
21	55	12 1/2	13	595	5156	4 1/2	3 1/2	3 15/16	4 5/16
22	75	14 1/4	16	667	6000	4 3/8	4	4 3/4	5 1/8
23	100	16	16	600	5850	5 1/8	4 5/8	5 1/16	5 1/2

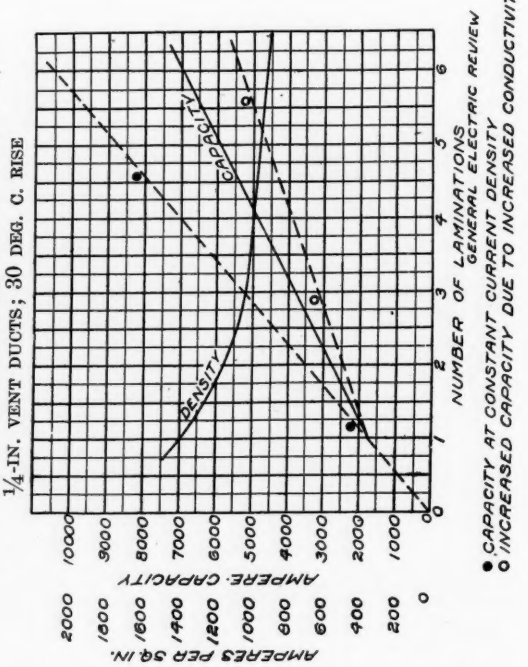
-GAS REVIEW-

EFFECT ON APPARATUS WHEN CHANGING FROM ONE LAMP VOLTAGE TO ANOTHER, AND POINTS TO INVESTIGATE

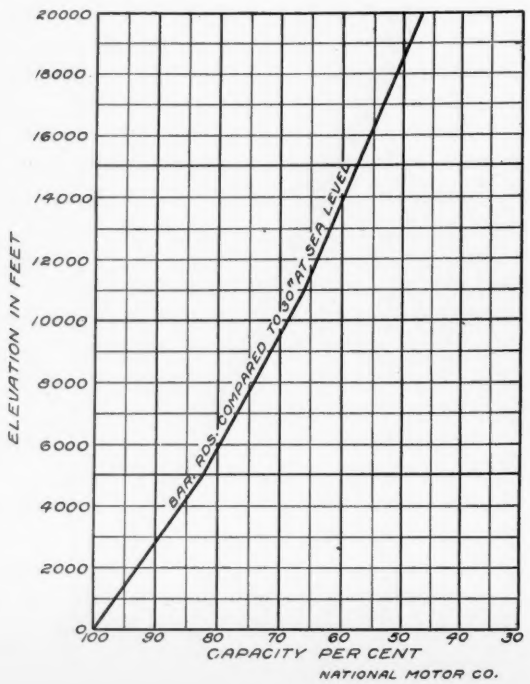
Effect of increased voltage on	Effect of decreased voltage on
GENERATORS: Increase in excitation. Will the exciter voltage be sufficient to produce the required excitation at full load, or at partial load of low power factor? Will the fields overheat at the increased excitation required? Increase in core loss. Will the iron overheat? Decrease in armature copper loss for same kva. output. Will this offset the additional field and core loss?	**GENERATORS:** Decrease in excitation. Is the resistance of the field rheostat sufficient to maintain the lower voltage at no load? Decrease in core loss. Increase in armature copper loss for the same kva. output. Will this be offset by the reduction in field and core losses?
LINES: Increase in transmission radius for the same kva. output.	**LINES:** Decrease in transmission radius for the same kva. output.
TRANSFORMERS: For the same kva. output, increase in core losses, decrease in copper losses, somewhat lower all day efficiency.	**TRANSFORMERS:** For the same kva. output, decrease in core losses, increase in copper losses, somewhat higher all day efficiency.
METERS: Effect negligible.	**METERS:** Effect negligible.
LAMPS: No effect after new voltage lamps are installed.	**LAMPS:** No effect after new voltage lamps are installed.
MOTORS: Reduced slip. Increased torque. Increased efficiency. Decreased power factor if induction motors.	**MOTORS:** Increased slip. Decreased torque. Decreased efficiency. Increased power factor if induction motors.

Electrical World

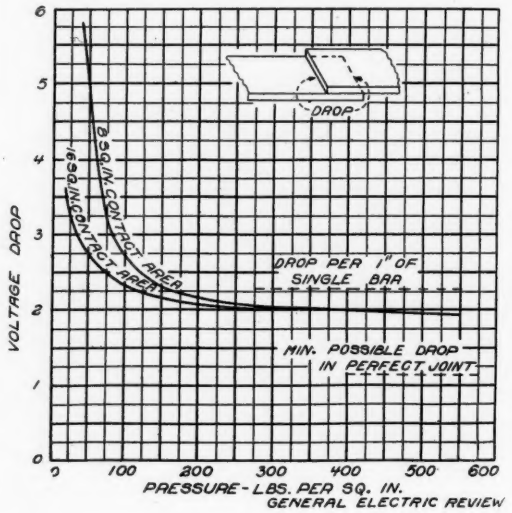
CURRENT DENSITY AND AMPERE CAPACITY (D.C.) FOR VARIOUS NUMBERS OF 5-IN. BY 1/4-IN. COPPER BUSBARS; 1/4-IN. VENT DUCTS; 30 DEG. C. RISE



CAPACITY OF GAS ENGINE AT ALTITUDES COMPARED TO SEA LEVEL RATING



VOLTAGE DROP PER INCH LENGTH OF LAP JOINT OF COPPER BARS UNDER VARYING PRESSURE. SURFACE CLEAN BUT NOT GROUND


VOLTAGE DROP
DROP
.25 SQ. IN. CONTACT AREA
.05 SQ. IN. CONTACT AREA
DROP PER 1" OF SINGLE BAR
MIN. POSSIBLE DROP IN PERFECT JOINT
PRESSURE - LBS. PER SQ. IN.
GENERAL ELECTRIC REVIEW

The Walco Hex Wrench

HEXAGONAL nuts are used almost universally in pipe-fitting work, but they approach so closely the circle that many are ruined through the use of an ordinary square jaw or a Stillson wrench. It is this inherent difficulty with hexagonal nuts that led to the development of the Walco Hex wrench by the Walworth Manufacturing Co.

WALCO HEX WRENCH

The illustration shows that the jaws of this wrench grip the nut positively on 4 of its 6 sides and thus give no chance for the wrench to slip if properly adjusted to the nut. Its qualities make this wrench ideal for making-up valves, cocks, bibbs and unions, as it will not mar even the most highly polished fittings. The jaws and handles are drop forged from tool steel while the frames are of malleable iron, and are made in sizes to fit hex nuts from ¾ to 2⅞ in. across the flat surfaces.

Catalog Notes

BUREAU OF MINES publications are now ready as follows, a limited supply being available for free distribution. Technical Paper 97, Saving fuel in heating a house, by L. P. Breckenridge and S. B. Flagg, 1915, 35 pp., 3 figs.; Technical Paper 104, Analysis of natural gas and illuminating gas by fractional distillation at low temperatures and pressures, by G. A. Burrell, F. M. Seibert, and I. W. Robertson, 1915, 41 pp., 7 figs.; Technical Paper 115, Inflammability of mixtures of gasoline vapor and air, by G. A. Burrell and H. T. Boyd, 1915, 18 pp., 2 figs.; Technical Paper 120, A bibliography of the chemistry of gas manufacture, by W. F. Rittman and M. C Whitaker, compiled and arranged by M. S. Howard, 1915, 29 pp. Order publications by number and title, addressing applications to the Director of the Bureau of Mines, Washington, D. C.

RADIATOR TRAP Sarco is described in a circular from Sarco Engineering Co., of New York. Illustrations show a few of the ways in which the trap, which operates in any position at any angle and adapts itself to any location of return piping, may be attached to radiators or coils.

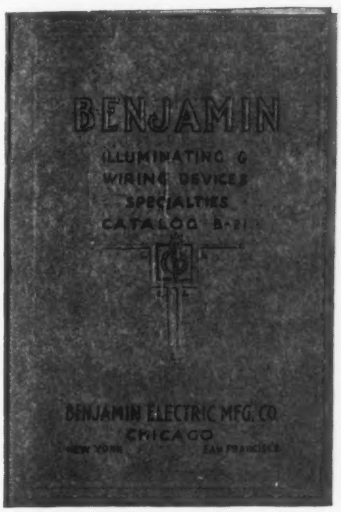
ARMSTRONG MFG. CO.'S Catalog No. 14 contains 56 pages on stocks and dies, water, gas and steam fitters' tools and pipe threading machines manufactured by the company at Bridgeport, Conn.

ECLIPSE STEAM SPECIALTIES are described and illustrated in a 40-page book, Catalog D, from Illinois Engineering Co., 1723 First National Bank Bldg., Chicago.

BULLETIN R, just published by Mesta Machine Co., Pittsburgh, Pa., describes the company's barometric condenser.

ATTRACTIVE, CONVENIENT and full of most helpful and useful information on illumination and the use of fixtures for different kinds of lighting, is the loose leaf catalog of Illuminating and Wiring Devices and Specialties, B-21, issued by the Benjamin Electric Manufacturing Co., of Chicago.

This is just from press, and shows the latest developments in modern illuminating methods. It is in convenient loose leaf form, so that additional sheets and data may be inserted, and has at the back a number of pages of cross section paper for the adding of data from other sources and from practice. For the convenience of users, goods are classified under the following schedules: First, Wireless Clusters and Plug Clusters; second, Reflectors and Lighting Fixtures; third, Special Mazda Fixtures; fourth, Wiring Devices and Specialties; fifth, Accessories; sixth, Tool Sets; seventh, Automobile Devices, each section being complete and having data in regard to the use of its particular articles, and full illustration and pricelist for each.



Under "illuminating data" are given the fundamental principles for satisfactory lighting, what to do work for, and what to avoid, intensity values of light for different classes of buildings, and a rapid method of calculating the illumination for any area.

Fixtures shown include all kinds of shades, and reflectors for direct, indirect and semi-direct systems, for street lighting, for protected lights and for special locations. The tool sets show convenient arrangements, with or without tool rolls, for the use of screw drivers, bits, awls, countersinks, reams, taps and dies in the Benjamin friction drive handles, and the Auto Device Section includes various types of horns and of quick contact buttons.

At the end of the catalog is a cross reference index which shows, for any article, under what schedule and on what page illustration and description may be found, gives the method of shipment, the number in a standard package, the weight and list price, so that a complete summary of all articles is given that makes reference instantaneous. The entire catalog has 100 pages, on a heavy enameled paper, and with durable covers fitted to take additional 6 by 9 sheets as may be desired.

BULLETINS have been received from Wagner Electric Mfg. Co., as follows: No. 109, on Single-Phase Converters for Motion Picture Projection; No. 110, Single-Phase Motors; No. 111, Polyphase Motors; No. 112, Generators and Synchronous Motors.

AUTOMATIC CIRCUIT CONTROLLERS for d.c. circuits, a new form of circuit breaker operating automatically, opening when overload or short circuit occurs and closing instantly upon removal of short circuit, are illustrated in a circular from The Automatic Re-Closing Circuit Breaker Co., Columbus, O.

INSTALLATION OF electric drive in steel mills has been interestingly described in Leaflet 3811, just issued by the Westinghouse Electric & Mfg. Co., in which is shown the curve indicating the growth of this form of power in steel mills throughout the country.

Trade Notes

CLEMENT RESTEIN CO., of Philadelphia, having changed its corporate title, will be known hereafter as the Belmont Packing & Rubber Co., whose address is 133-35 North Second St., Philadelphia, Pa. The corporate organization and personnel of the company remain the same.

THE VILTER MFG. CO., Milwaukee, Wis., reports the following recent installations:

Shays Cafeteria, Salt Lake City, Utah, a 12-ton refrigerating plant; Irion & Craig, Niami, Ariz., a 12-ton refrigerating plant; The Model Grocery Co., Pasadena, Cal., a 15-ton refrigerating plant; The Los Angeles Tuna Co., Long Beach, Cal., a 25-ton refrigerating plant; The Aluminum Goods Mfg. Co., Manitowoc, Wis., an 18 by 30-in. rolling mill type Corliss engine; F. & M. Schaefer Brewing Co., Brooklyn, N. Y., a 200-ton refrigerating plant; The Kent Storage Co., Grand Rapids, Mich., 6450 ft. of 2-in., full weight, direct expansion piping; The American Ice Co., Station No. 16, Baltimore, Md., 4 standard cast-iron headers for thawing system.

THE WESTINGHOUSE ELECTRIC & MFG. CO. reports the receipt of the following orders:

The Hartford Electric Co., Hartford, Conn., 2 2500-kv.a., one-phase, 60-cycle, 11,000-v. high tension, 2400-v. low tension, forced oil-cooled transformers of the standard shell type of construction; Ogden, Logan & Idaho Railway Co., Ogden, Utah, 2 stationary substations each consisting of a 500-kw. motor-generator set, 2300-v., 3-phase, 60-cycle, 900-r.p.m. synchronous motor, 1500-v., direct-current generator, 10-kw., direct-connected exciter; 3 235-kv.a., single-phase, 60-cycle, O.I.S.C. transformers, 45,000/2300-v. and switchboard, also a portable substation with similar equipment using 3 187½-kv.a. transformers, this apparatus being in addition to the original order given the Westinghouse Co. a year ago and for the completion of the line between Ogden, Utah and Preston, Idaho; Stevens County Power & Light Co., one 900-kv.a., 11,000-v., 3-phase, 60-cycle, 600-r.p.m., 2-bearing, horizontal coupled-type generator for water wheel drive with 11½-kw. direct-connected exciter, one 250-kv.a., single-phase, 60-cycle, 33,000/11,000-v. O.I.S.C. transformer, one 250-kv.a., single-phase, 3300/2300-v. O.I.S.C. transformer; and one 6-panel switchboard.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year, each insertion, $20.00.

Eighth page, one year, each insertion, $12.00.

Front cover, $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—As Meter Foreman and Power Salesman. Have had nine years' practical and technical experience. Thoroughly familiar with the requirements of the Public Service Commission of Pennsylvania. Address Practical Engineer, Box 405, Chicago, Ill. 11-1-2

POSITION WANTED—By man of good habits. Age 30. Technical education; 12 years machinist and electrician; 2 years engineer; 2 years salesman. What have you? Address Practical Engineer, Box 401, Chicago, Ill. 11-1-2

POSITION WANTED—Steam engineer wants position in water works or mill plant; 33 yr. old. Married. Sober. Best of references. Iowa preferred. Address F. J. Kirkpatrick, Indianola,, Iowa. 10-15-3

POSITION WANTED—By engineer, 8 yr. experience with steam and electric. Understand gas engines and refrigeration. Temperate, reliable, married man. Member N. A. S. E. Address W. H. Snyder, 53 Brown St., Hartford, Conn. 10-15-3

POSITION WANTED—By engineer, age 37, married, where reliability, capability, efficiency and economy would be appreciated. Prefer Chicago or vicinity. Address Practical Engineer, Box 411, Chicago, Ill. 11-15-1

POSITION WANTED—Stationary Operating Engineer, age 27 years, quick learning and a hustler, wants position with a Mechanical or Electrical Engineer or Concern, with chance for advancement. Address Practical Engineer, Box 407, Chicago, Ill. 10-15-3

POSITION WANTED—Chief Electrician. Young man having had long experience in installing, maintaining and repairing in A.C. and D.C. plants, desires to take charge where improvements in motor operation will be welcomed. Address Practical Engineer, Box 409, Chicago, Ill. 11-1-2

POSITION WANTED—As advance sales prospect man with firm manufacturing or selling power plant machinery, by thoroughly practical engineer with several years' traveling experience. Can furnish my own auto if desired. Address Practical Engineer, Box 412, Chicago, Ill. 11-15-1

POSITION WANTED—As operating engineer; perfectly at home in either electric lighting or ice plants; 15 years' continuous experience; married, sober and reliable man. Address E. S. C., care Practical Engineer, Chicago, Ill. 11-15-1

POSITION WANTED—By man 26 years of age. Have had 28 months' experience as general man around stationary power plant, and 2 yrs. running traction engine; also hold fireman's license. Reference will be furnished to any one wishing to correspond with me concerning position. Address Geo. M. Bucey, 1614 O St., Lincoln, Neb. 11-1-2

Help Wanted

DISTRICT MANAGER—A Chicago engineering and realty corporation has a permanent position with a good future to offer as manager of Minneapolis office. A successful business man with executive ability and engineering knowledge and who is in a position to take financial interest of not less than $2,500 are the requirements. Investment fully secured. To such a party we will give guaranteed contract with salary, commission, expenses and profit-sharing interest. Give full statement in first letter. Address Practical Engineer, Box 414, Chicago, Ill. 11-15-1

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Calif.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Calif.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEER BOOKS and power plant tool and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

WANTED—Sales representation desired by one of the best known manufacturers of feed and service water heaters in the following territories: Indiana, Western Missouri, Kansas, Nebraska, Iowa, Pacific Coast. State lines you are now handling with application. Address Practical Engineer, Box 413, Chicago, Ill. 11-15-1

Wanted

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried, and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

16 x 30 ALLIS (Reliance type) Corliss engine, heavy duty frame; practically new (cost $2,800); price, $750. 20 x 42 Ohio Corliss engine; heavy duty; perfect condition; $850. Two 350-HP. Sterling watertube boilers, 160 lb. steam pressure, 6 months' service; practically new; $2,600 for both. Two 250-HP. Heine watertube boilers, 150 lb. steam pressure; perfect condition; $2,000 for both, including stack. Duzets & Son, Hudson Terminal Bldg., New York. tf.

FOR SALE—(Model) Corliss Engine castings, cylinder 2 by 4½ in. Ask for circular. F. L. Peterson, 14 Bourne St., Worcester, Mass. 11-15-1

FOR SALE—11 H.P. Foos gasoline engine. Bargain H. L. Baker, Cambridge, Mass. 11-15-1

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C.

DON'T LOSE YOUR RIGHTS to patent protection. Before proceeding further send for our blank form, Evidence of Conception, to be signed and witnessed. Book, suggestions and advice free. Lancaster and Allwine, 292 Ouray Bldg., Washington, D. C. 11-15-1

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St. N. W., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Education and Instruction

ENGINEERS' POCKET MANUAL; 175 pages; gilt edges; bound in leather; edited by University of Tennessee; will be mailed every subscriber sending in one NEW subscription (not your own) to Practical Engineer.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Inventions

INVENTIONS commercialized on cash and royalty basis. Inventors and manufacturers should write Adam Fisher Mfg. Co., 2175 Railway Exchange, St. Louis, Mo. tf.

Sparks From The Advertising Pages

For This, We Are Thankful

In keeping with the annual custom, national and state officials have issued proclamations declaring November 25, Thanksgiving Day.

Only twice since this nation was established has there been greater cause for thanksgiving.

This festival of thanksgiving has not always been an annual celebration. Time was when it was observed only on special occasions as, for instance, in 1784, when Congress recommended a day of thanksgiving to observe the return of peace, and also in 1815, when President Madison set apart a day for the same reason.

However, since 1863 Thanksgiving Day has been an annual occasion, and we are to observe it this year not for the *return* of peace, as did this nation in 1784 and 1815, but for the fact that we have not been embroiled in the terrible war that is now devastating Europe.

And yet this peace which the United States is enjoying is peace with honor and respect. We have been able to assert our rights without breach in our international relations.

May we also be thankful that the United States has again reached its normal state of trade-activity which has caused Secretary McAdoo to say, after traveling extensively throughout the country, "I have reached the conviction that this country is in the midst of an era of tremendous prosperity. Wherever I have looked I have found business booming. Not a factory was idle. Not a wheel that was not turning. Prosperity is everywhere."

Let us not forget that we are living in a land that is rich in opportunity—where knowledge, not hereditary influence, is the open sesame of advancement and happiness—and within whose boundaries the native born can rise, yes, to the highest office of national service and where all, natives or aliens, have equal rights to scientific and industrial opportunities. The only prerequisite is *I Will.*

So let the profoundest gratitude for the gifts of peace and prosperity—for the opportunity of moulding our futures as we *will,* be natural emotions in the breasts of each one of us during this—the Thanksgiving Season of the year.